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Weekly

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SHIPBUILDING MINING
IRON & STEEL INDUSTRIES

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PROGRESS OF THE ENGINEERING WORLD.

PAGE'S MAGAZINE

An Illustrated Technical Monthly, dealing with the Engineering, Electrical, Shipbuilding, Iron & Steel, Mining, & Allied Industries.

DAVIDGE PAGE, Editor,

Clun House, Surrey Street, Strand, London, W.C.

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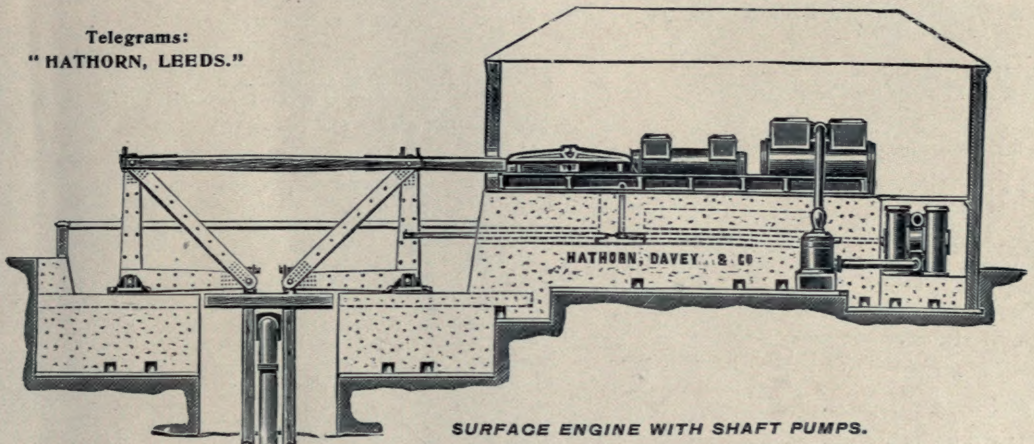
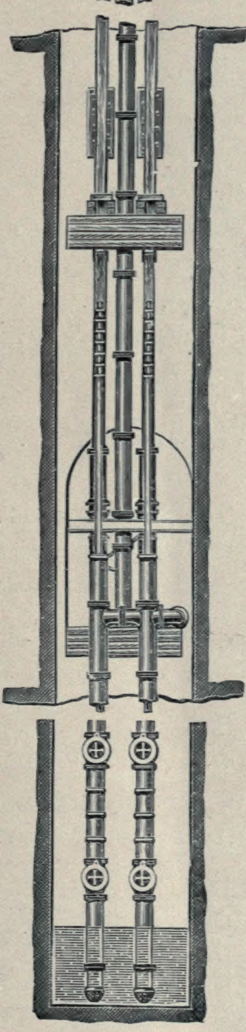


SURFACE ENGINE WITH SHAFT PUMPS.



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In order to assure fair treatment to advertisers, each firm is indexed under its leading speciality ONLY.

Advertisers who prefer, however, to be entered under two or more different sections can do so by an annual payment of 5s. *for each additional section.*

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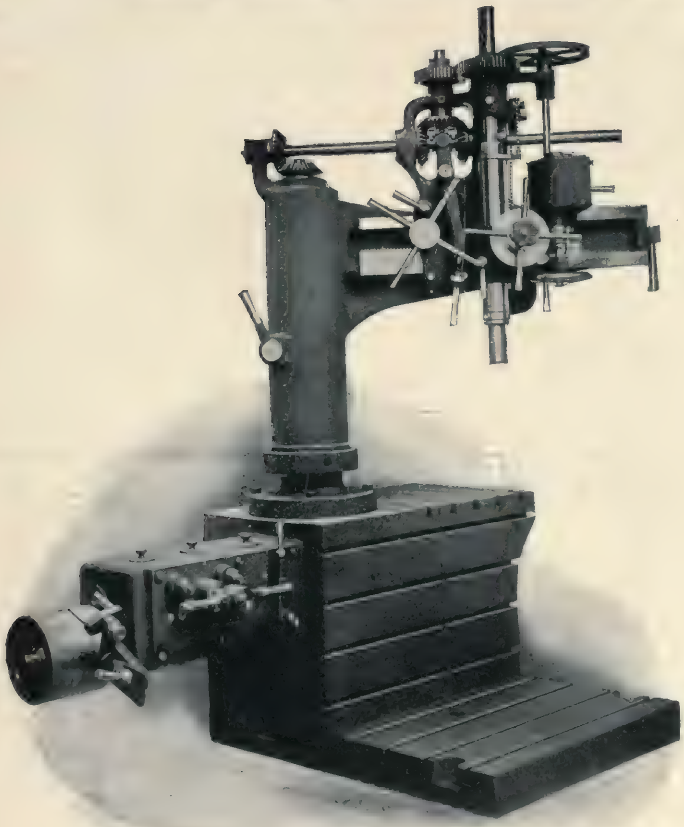

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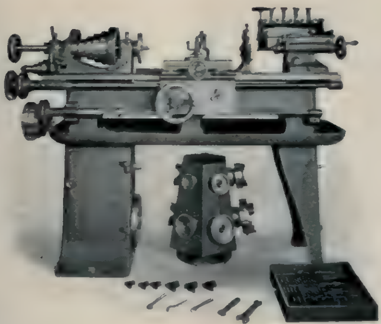
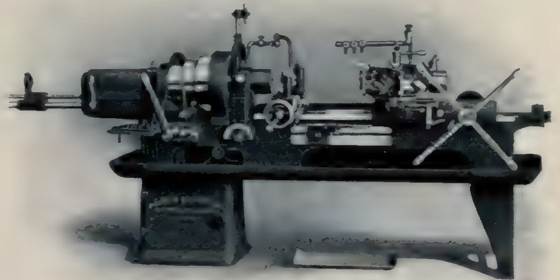


10 in. by 5 ft. Toolmaker's Engine Lathe.



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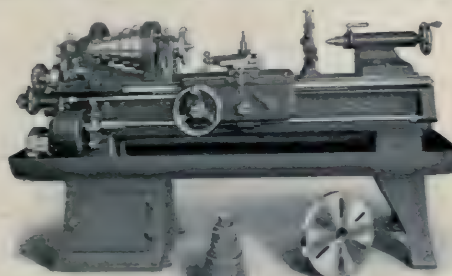

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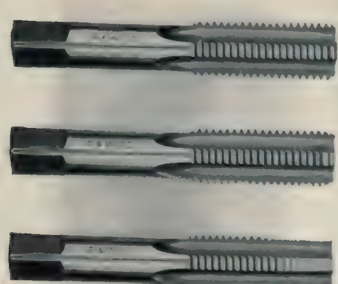

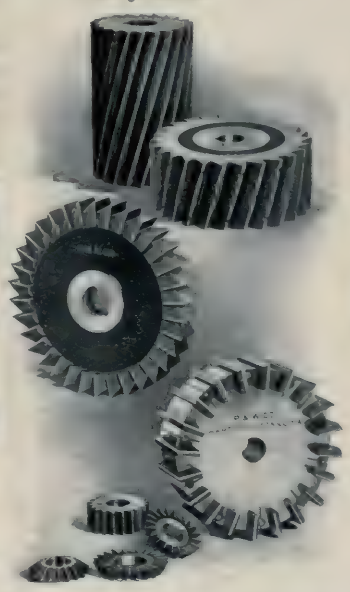

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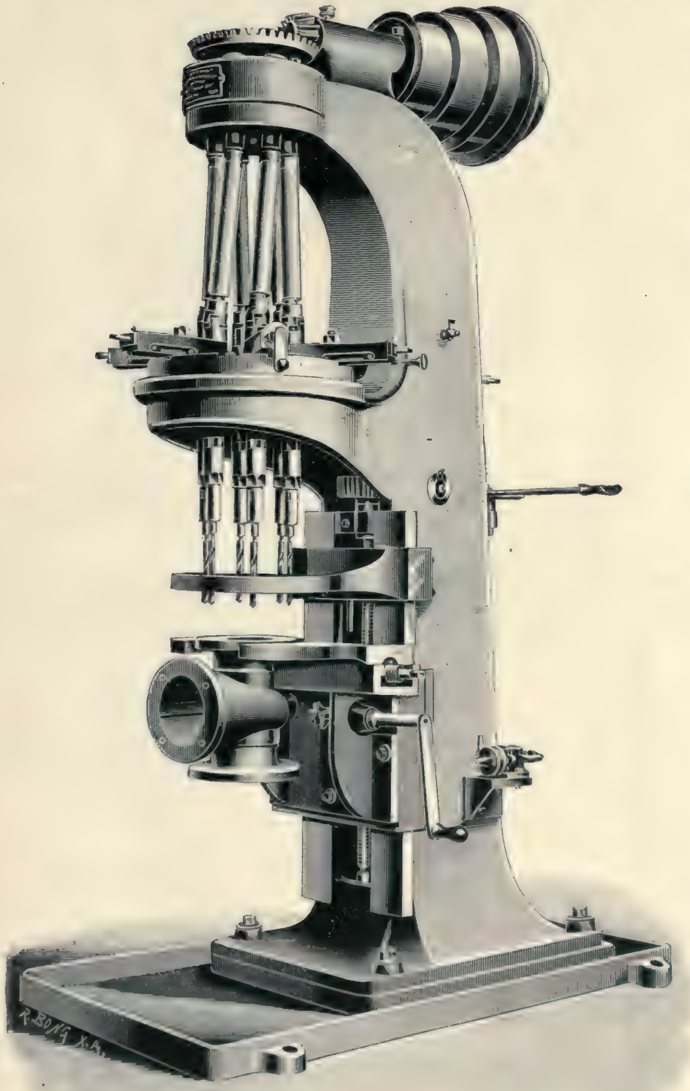

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With any number of Spindles individually adjustable to any point within a given circle, for drilling Screw, Bolt or Rivet Holes in Girder Work, Rails, Fish-plates, Plates for Ships, Boilers, and Locomotives, &c., &c.

Phœnix Drill, System "C."

A combination of the two previous types. As this type possesses all the qualities of the machines in Systems "A" and "B," it can be used for drilling all the work enumerated above.

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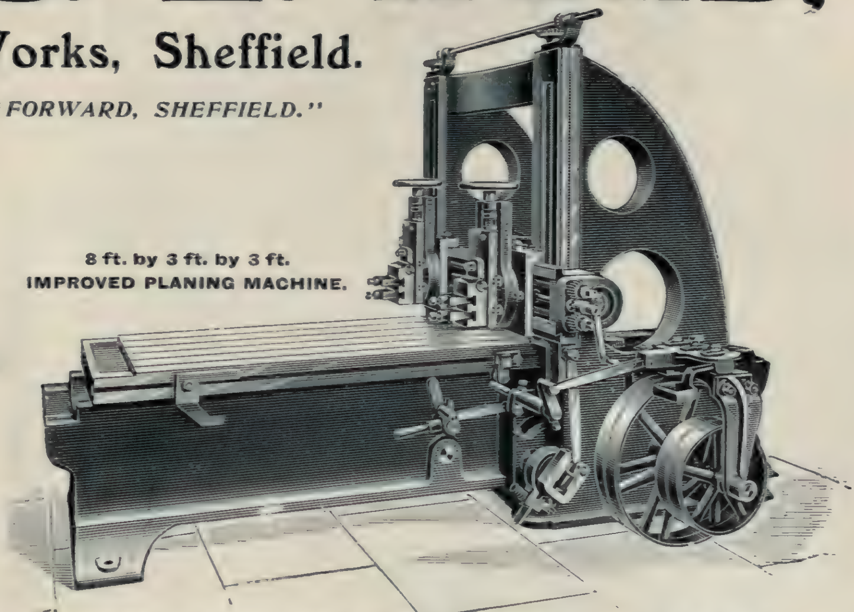

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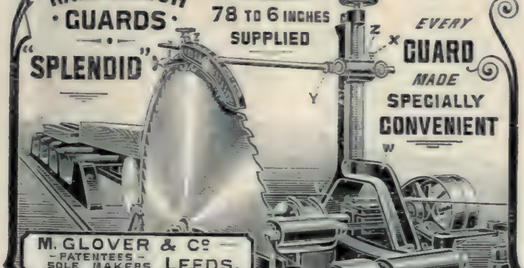

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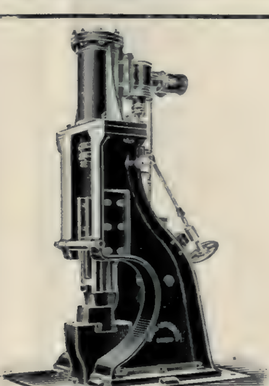

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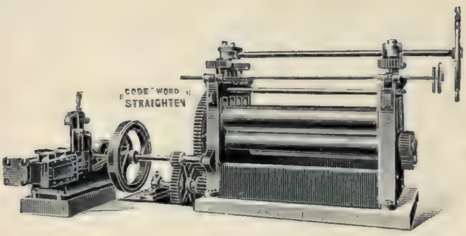

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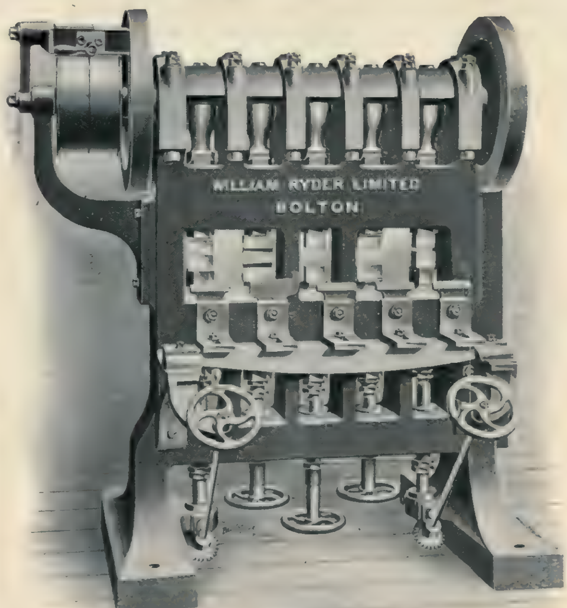

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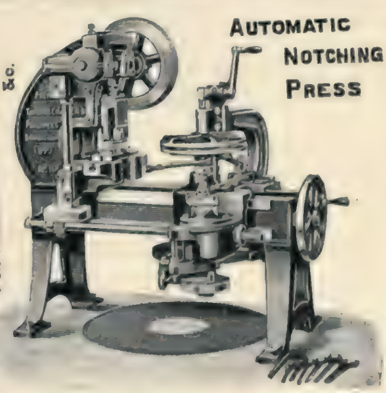

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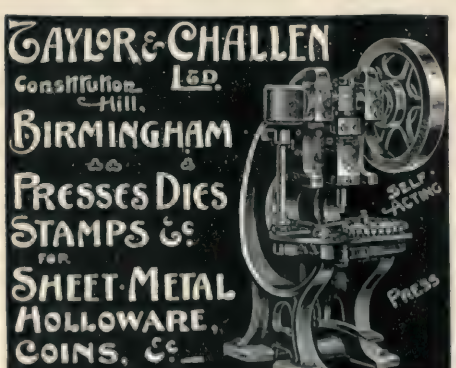

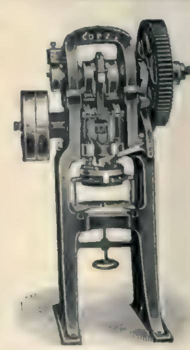

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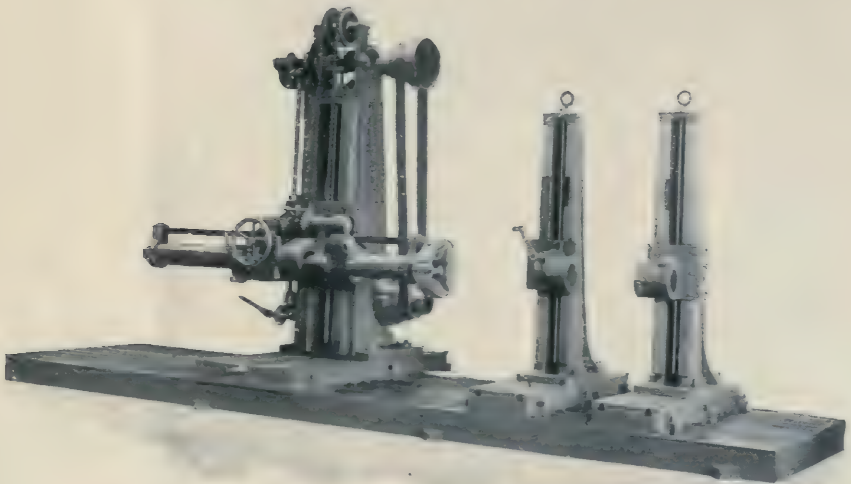

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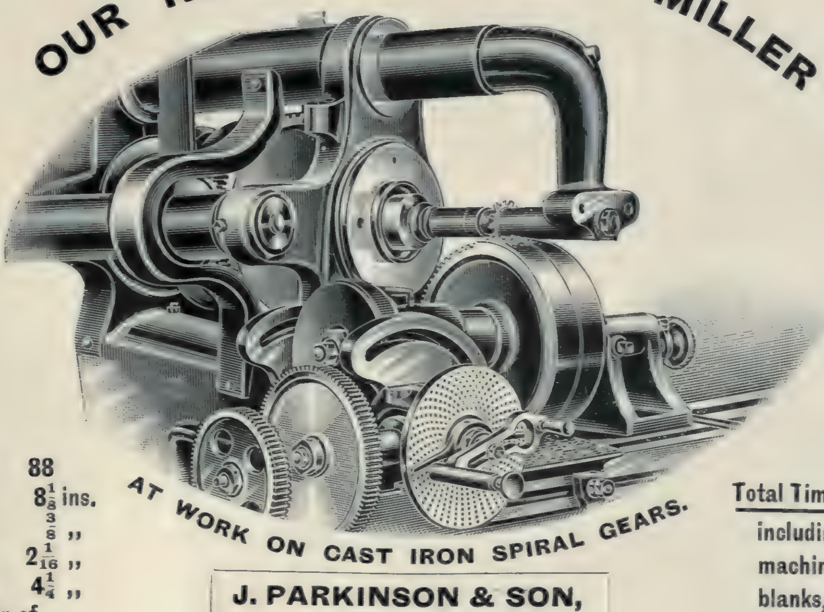

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No. of Teeth	88
Outside dia.	$8\frac{1}{8}$ ins.
Pitch approx.	$\frac{3}{8}$,,
Width of Face	$2\frac{1}{16}$,,
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Time for 1 pair of Gears, $2\frac{1}{2}$ hrs.

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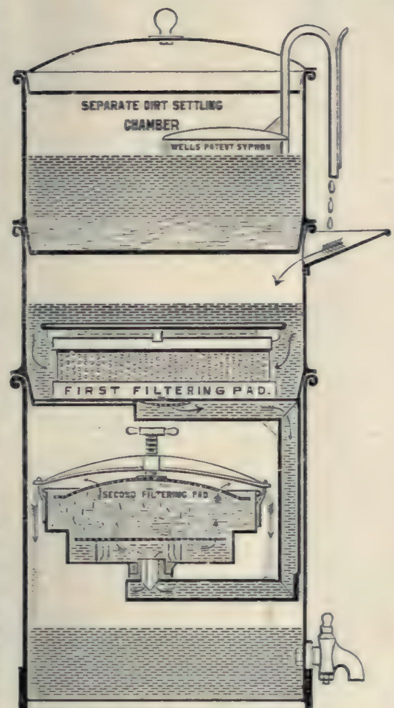

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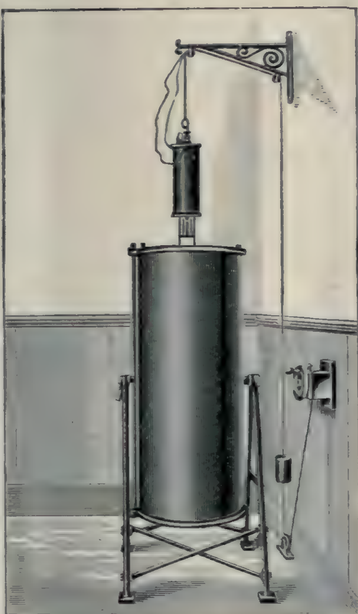

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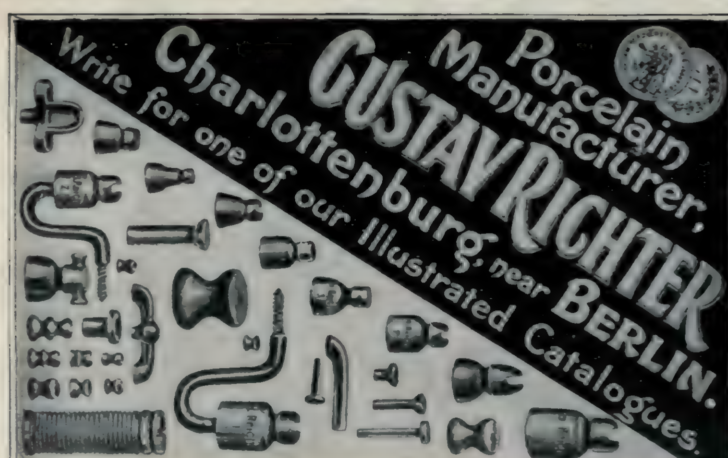

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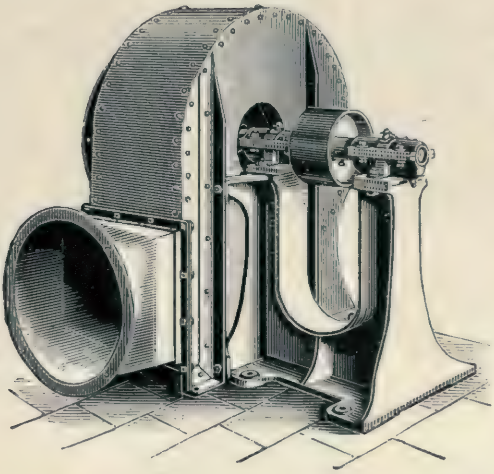

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or weight had been duly checked by the storekeeper, and the quantity or weight is surely not of more importance than the quality. English designs of commercial testing machines vary widely from those of other countries ; with few exceptions the principal English machines have long levers, with heavy poise weights and knife edges comparatively long distances apart. American testing machines usually have a multiplicity of levers of high ratio, and, consequently, small poise weights on short steelyards; whilst German machines such as the Werder, the Grafenstaden, and those of Mohr and Federhaff have their knife edges exceedingly close together, so that, with simple or compound levers, only light poises are employed, or, in the case of the Werder, the scale pan is suspended from the end of a short lever.

In selecting types of English testing machines for the purpose of illustrating this article, the author has confined the selection as far as possible to commercial patterns in preference to machines specially designed for research work in technical laboratories.

At the present time the type of machine most in vogue in this country is the vertical single-lever machine, which can be arranged for tensile, compressive, crushing, and torsion tests. This class of machine was originally designed by Mr. Wicksteed, and built by Messrs. Joshua Buckton and Co., Ltd. Machines on the same general principle are also made by Messrs. Greenwood and Batley, Ltd., and Messrs. Tangyes, Ltd., a 30-ton machine by the former being shown in fig. 1.

It will be seen that the machine consists of a substantial standard with hydraulic straining cylinder at its lower end, and with the heavy weigh beam mounted on top of the standard ; the poise weighs 20 cwts., and, as is usual with this type of machine, travels from one end of the weigh-beam to the other ; when at the right hand of beam it counter-balances the long arm of the lever, and thus obviates the necessity of using a separate counterweight. The poise is moved along the weigh-beam by means of a screw, rotated by belt, and gearing from the hand-wheel, the transmission passing through a

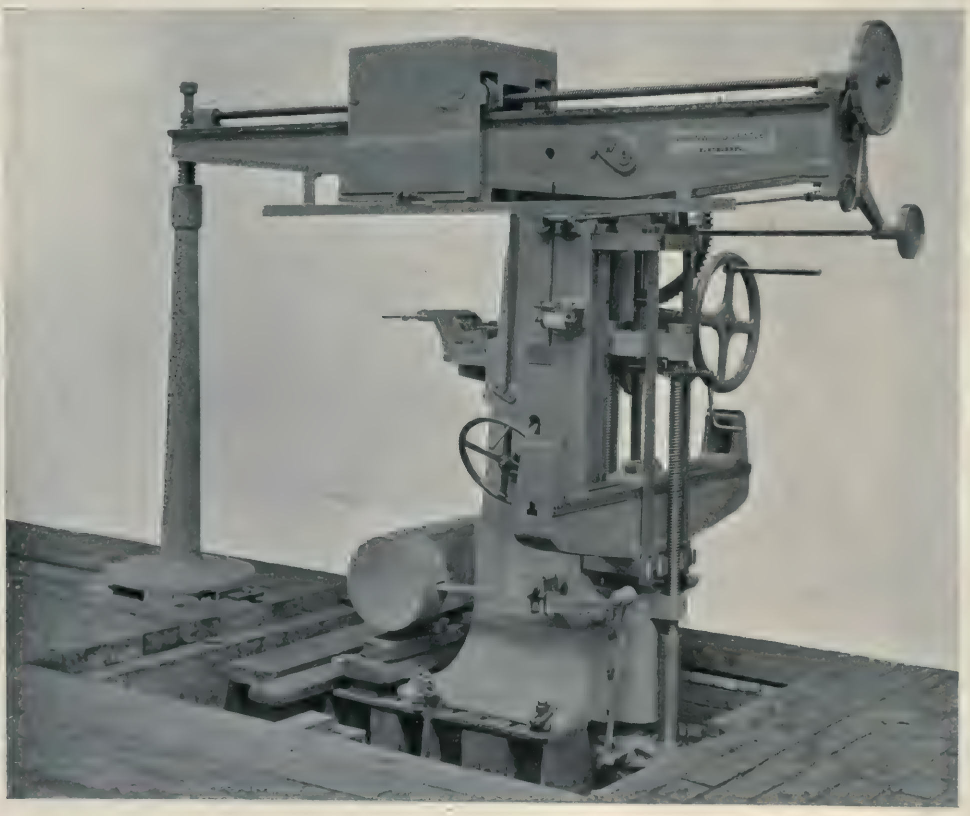


FIG. 1. VERTICAL SINGLE LEVER 30-TON MACHINE BY MESSRS. GREENWOOD AND BATLEY, LTD.

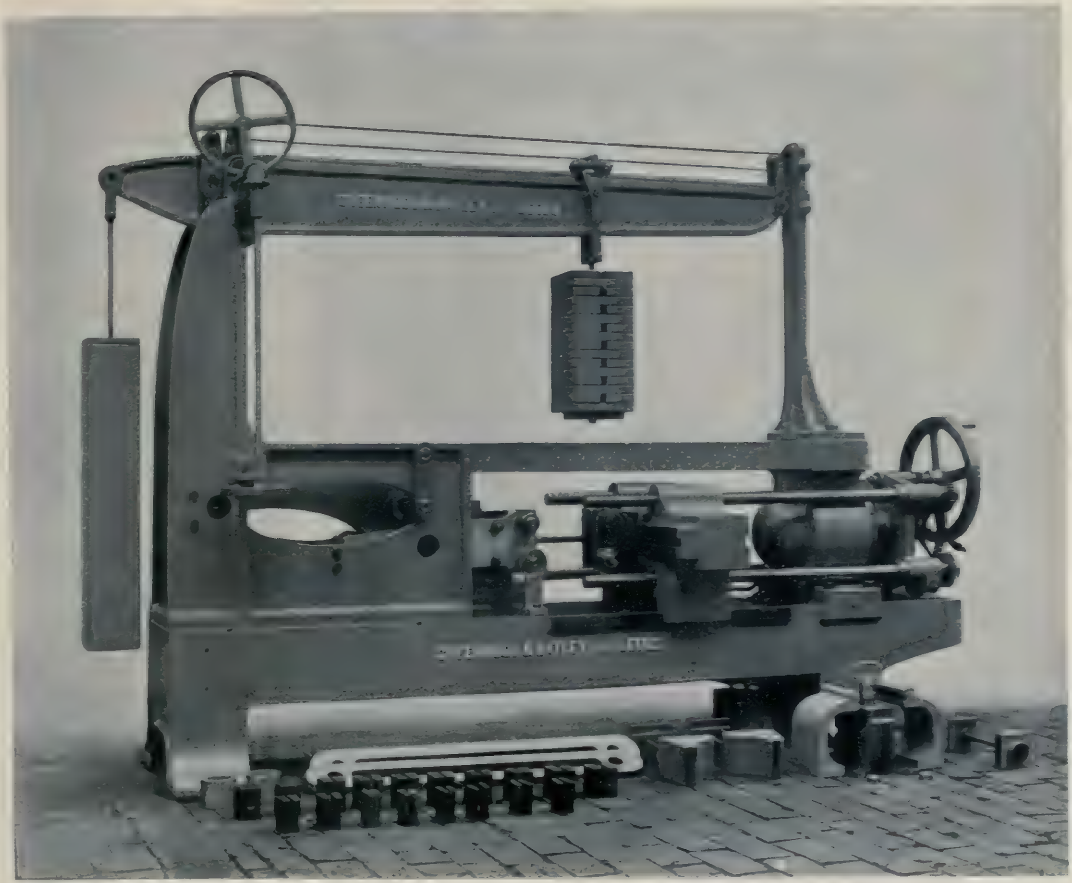


FIG. 3. A GREENWOOD AND BATLEY COMMERCIAL PATTERN 50-TON MACHINE.

Hooke's joint in line with the axis of the principal knife edge. The load is read from a scale attached to the lever and by a vernier on the poise; the reading being in tons and one-hundredths of a ton. The lever is brought into equipoise by the position of the weight and the vernier is then adjusted to the zero mark on the scale; this is necessary every time the shackles are changed, or specimens of different weights are being tested. The photograph shows the machine fully equipped for tensile, compression, transverse, or torsion tests, and an autographic recording apparatus will be noticed on the side of the standard above the hand-wheel.

Figs. 2 and 3 are from photographs of two other patterns of the same firm's horizontal machines, the former being a machine of 120-tons power and the latter the Greenwood and Batley commercial pattern 50-ton machine. In both machines the scheme is the same, viz., a horizontal hydraulic ram applies a strain to the specimen which the latter transmits to the shorter end of a bell-crank lever, whose longer arm is connected by a link rod to the steelyard lever, which is counterbalanced by a pendant weight. The ratios of the combined levers in the two classes of machines are 250 : 1 and 100 : 1 respectively.

The method of loading the steelyard is a distinctive feature of the older Greenwood and Batley machines—a travelling monkey-carriage is propelled along the steelyard by a gut band, from the carriage hangs a weight pan upon which may be placed any desired number of flat weights representing certain values. The steelyard is not marked in tons or pounds, but in *proportions of leverage*, so that to arrive at the result of a test it is necessary to multiply the reading on the steelyard by the value of the weights on the monkey-carriage. Some engineers are very partial to this arrangement, because it enables the same machine to be used for widely different tests, as by using only a few weights a specimen of small size or low strength

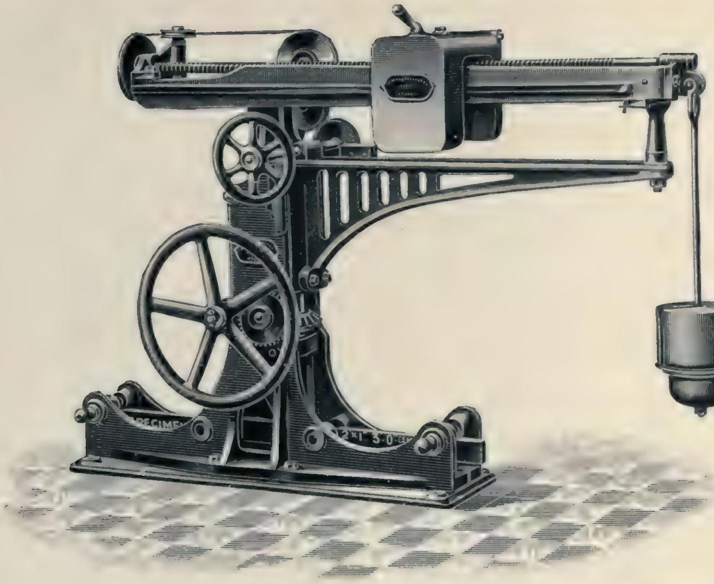


FIG. 4. 40-CWT. TRANSVERSE TESTER BY MESSRS. S. DENISON AND SON.

can be tested, and the extension noted across the full range of the steelyard, as against, perhaps, an inch or two of the scale if the test were being carried out on the type of machine shown in fig. 1. The horizontal machine has, however, the great disadvantage of being difficult to calibrate, whilst the vertical machine can have its accuracy easily tested by hanging heavy weights of known value from the shackle, and noting the reading of the vernier.

A pleasing exception to the majority of transverse testers is the small 40 cwt. machine of Messrs. S. Denison and Son. This is illustrated in fig. 4, and an inspection will reveal that the machine has been carefully thought out, and has had considerable attention bestowed on its design. This machine is arranged for the two standard sizes of test-bar, viz., 2 in. by 1 in. at 36 in. centres, and 1 in. square with 12 in. span. The load is applied by a screw, bevel gears, and hand-wheel, causing the bracket carrying the steelyard to rise vertically in a slide on the machine frame. The steelyard lever is connected to a shackle through which the test-bar passes, this exerting a bending stress in the centre of the specimen. The load is indicated by the position of the poise on the steelyard lever, which is engraved to give readings up to 30 cwts., whilst a weight to increase the total to 40 cwts. can be hung from the outer end of the steelyard. The movement of the poise is travelled by a screw and gearing, the pitch-line of the latter passing through the axis of principal knife edge; after a test the poise can be brought back to zero by a handle, which disengages the nut from the screw. In the author's opinion, it would be a distinct advantage if the steelyard gave direct readings up to 40 cwts.

A compact machine for testing materials in torsion, as made by Messrs. W. and T. Avery, Ltd., is shown in fig. 5. The capacity of this machine is 10,000 inch-pounds, and will admit specimens up to 12 in. long by 1 in. diameter. Between the specimens and the weigh-beam or steelyard are two levers so arranged that the ratio of leverage can be varied for testing pieces of high or low resistance.

(To be continued.)

FIG. 5. MACHINE FOR TESTING MATERIALS IN TORSION BY MESSRS. W. AND T. AVERY, LTD.

The Electro-Capillary Recorder for Cable Purposes.

BY

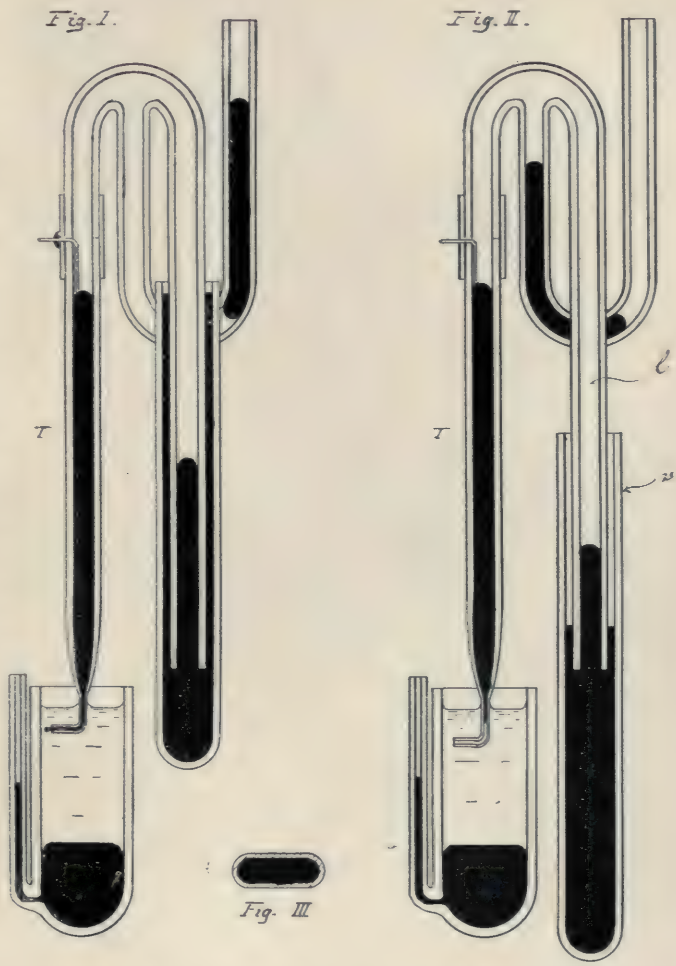
J. TARBOTTON ARMSTRONG AND AXEL ORLING.

The following notes deal with an instrument which it is confidently predicted will create a revolution in cable telegraphy, by accelerating the speed of reception, and effecting a great reduction in the cost of messages. Under proper conditions, the inventors claim that they are able to receive with their instrument messages at the rate of not less than four hundred to five hundred letters a minute.—Ed.

EVERYTHING relating to the cheapening of cabling and telegraphy is of the greatest importance to any and every country. It is doubtful whether the public fully realise the magnitude and serious character of the work that is accomplished by the establishment of submarine telegraph communication. Nothing is of more importance to the extension of trade and the bringing together of the ties which bind nations closely to one another than those silent messages which are constantly, almost momentarily, being dispatched to every part of the world by means of these submarine telegraphs, and there is no doubt that the spinal cord of civilisation would become severed if it were not for this means of international relationship.

Anything therefore that tends, even to a fractional extent, to the cheapening of cable or other telegraphic messages, materially influences political, diplomatic, financial, commercial, and social relations. There is no doubt that the extension of the British cable system must in a great measure solve the vital problem of British Imperial federation—that great dream which is contemplated in the near future may become a reality. The more numerous the cables, the greater the degree in which the cost of messages can be reduced under British influence throughout the world, the more will British commerce extend, since there is no other means of so quickly creating new markets.

Questions of great moment in diplomacy



FIGS. 1, 2, AND 3. SHOWING MEANS OF ADJUSTMENT.

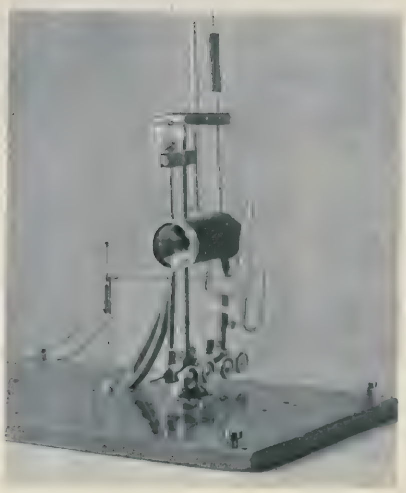


FIG. 4. THE FIRST ELECTRO-CAPILLARY CABLE RECORDER.

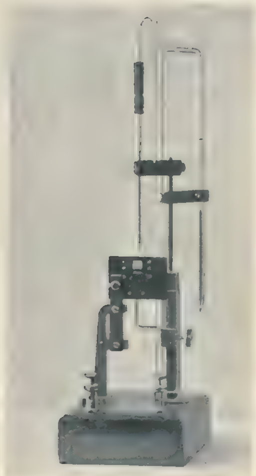


FIG. 5. ELECTRO-CAPILLARY RECEIVER FOR CABLE RECORDER.

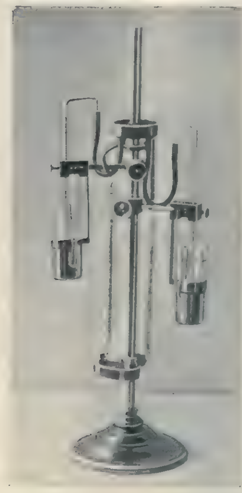


FIG. 6. ELECTRO-CAPILLARY RECEIVER FOR DUPLEX TELEGRAPHY.

instead of taking, as they used to do, months to settle, are now adjusted in a few days ; in fact, it is difficult to say what has not been revolutionised by the world's cables, for they not only assist in time of peace in the improvement and development of commerce, but in the time of war their usefulness is paramount.

The scientific organising and administrative ability of those in charge of the various cable companies is obvious and admirable, some of the best men of industrial enterprise being engaged in their promotion and control. Between twenty and thirty thousand men are at the present moment engaged in the various branches of cable work.

The electro-capillary phenomenon upon which the Armstrong-Orling Electro-Capillary Telegraphic Relay and Recorder are based was first observed by Kuhne. He found that when a fixed piece of iron wire touches the edge of the surface of a drop of mercury placed in dilute sulphuric acid (containing a small

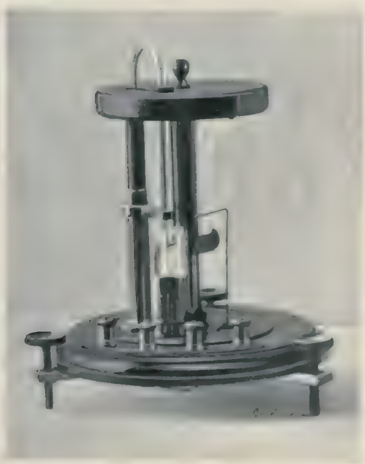


FIG. 7. ELECTRO-CAPILLARY RECEIVER.

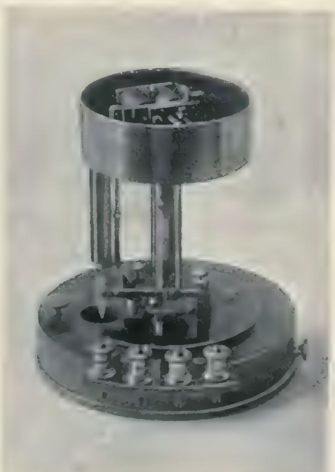


FIG. 8. ELECTRO-CAPILLARY TELEGRAPHIC RELAY.

FIG. 9. ELECTRO-CAPILLARY RECEIVER FOR HERTZIAN WAVES.

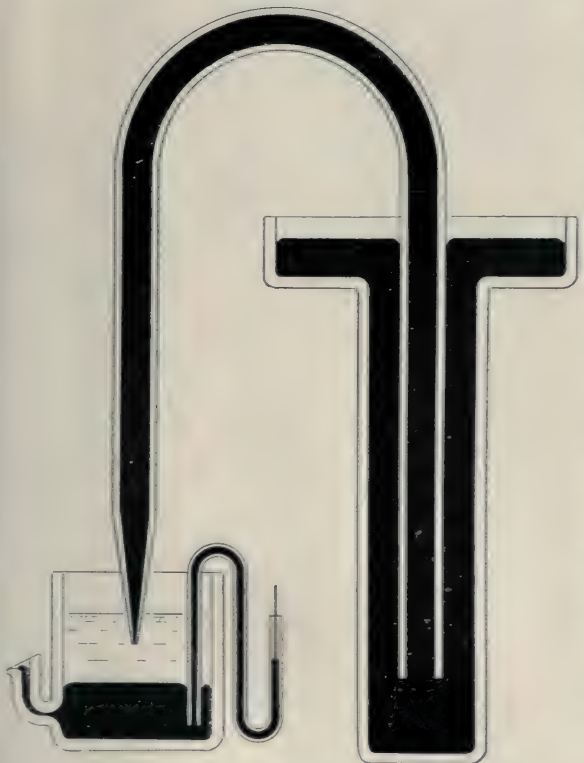


FIG. 10. ARMSTRONG-ORLING DROPPING ELECTRODE.

quantity of chromic acid) the mercury begins to vibrate.

An iron-mercury couple is formed when the contact is established between the two metals, which causes the surface of the mercury to be polarised by a layer of hydrogen. This polarisation increases the surface tension of the mercury, and causes the drop to assume a more spherical shape and thus breaks the circuit. The chromic acid depolarises the mercury, its normal shape is restored, the circuit is completed again, and this process repeats itself.

This phenomenon led Prof. Lippman to invent the electro-capillary electrometer, 1875. This electrometer consists of a glass tube, one end of which is drawn out to a fine capillary end, and is filled with mercury; this end dips into a vessel, containing dilute sulphuric acid and mercury. As terminals, platinum wires are fixed in the vessel.

If now a potential difference is set up, so that the mercury in the vessel is slightly higher than that in the capillary tube, the surface tension of the mercury in the latter is increased, and the meniscus of the mercury ascends.

Lippman found that the pressure required to force the meniscus back to its former position against a potential difference up to 0·6 volt is directly proportional to the difference of potential. This pressure he applied by means of an elastic bag, connected with the top and with a manometer, and used a screw to effect the required compression.

On account of its great sensitiveness, Maray employed this electrometer in his investigations of the functions of the electrical organ of the torpedo.

In 1882, Prof. Burdon Sanderson, by means of Lippman's electrometer, slightly modified by himself, proved that the closure of the leaf of the Venus fly-trap is accompanied by electrical changes.

Quite unaware of the experiments of Helmholtz in this field, Armstrong and Orling constructed dropping electrodes of various forms in 1898, which they applied practically in connection with Hertzian wave telegraphy.

For high-speed telegraphic recording purposes, they use an arrangement in which the meniscus lies in the path of a beam of concentrated light, which is thrown upon a sensitized travelling tape. The movements of the mercury, which are governed by the transmitted impulses, are thus recorded photographically on the tape. This instrument has now reached a

FIG. 11. THE LATEST CAPILLARY RECORDER.

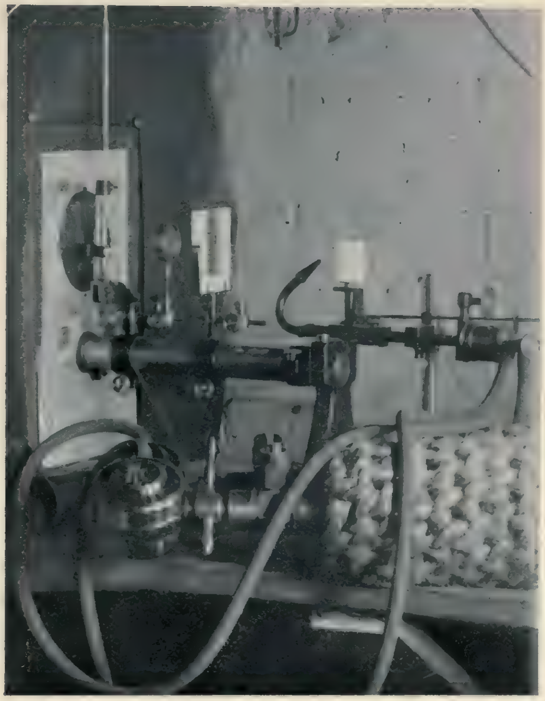
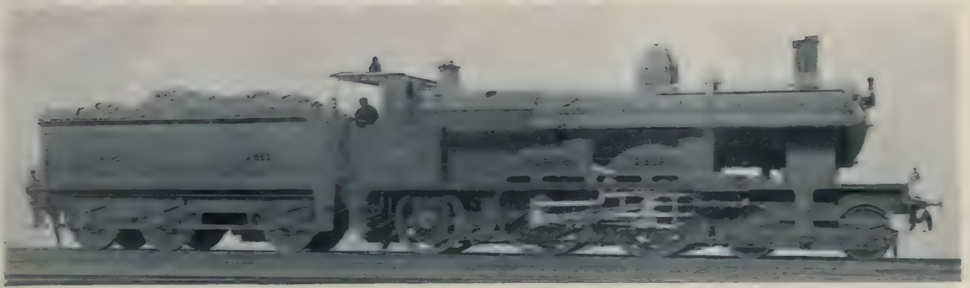


FIG. 12. THE ARMSTRONG-ORLING CABLE RECORDER WITH LIMELIGHT ATTACHMENT.

high pitch of perfection, and is the most suitable device for long cables or land lines.

This Capillary Recorder may be actuated by extremely small differences of potential, and owing to the small mass of the moving part (whose movements are to be recorded on the tape), and the consequently small inertia to be overcome by the electrical energy, responds almost instantaneously to any changes in the actuating potential difference. Hence its adaptability for long distance cable and other work. The Siphon Recorder, on the other hand, now so widely used for long cables, depends on an electro-magnetic field which is set up in a suspended coil (whose movements are to be recorded on a tape) by the current received through the cable, which causes it to move in a stationary field. The coil being several hundred times heavier than the moving part in the Capillary Recorder, offers considerable mechanical resistance to the small force that is to move it. Therefore the siphon recorder coil cannot respond so rapidly to electrical changes.

Authorities are of opinion that electrical energy rushes along a conductor with a velocity very much the same as that of light, but although some of the energy reaches the distant end of a cable almost instantaneously, the cable, having a high electro-static capacity, has to be charged before a potential difference sufficient to work the receiving instrument can be built up. It then takes time for such an impulse to die out. Therefore the more sensitive the receiver is to small changes of potential difference, the more suitable it is for long submarine cables, where high efficiency is wanted. Now it is said that if the receiver is too sensitive it would be too readily affected by outside disturbances and record unreadable signals. Such is the case with a slow working recorder whose curved recorder line has its signals comparatively far apart, but as the Capillary Recorder permits of a very high speed, the curves due to ordinary disturbances do not interfere enough with the actual signals to make them unreadable.



ONE OF THE DU BOUSQUET DE GLEHN COMPOUND LOCOMOTIVES.

OUR MONTHLY BIOGRAPHY.

MONSIEUR DU BOUSQUET,

Ingénieur en Chef du Matériel et de la Traction du Chemin de Fer du Nord.

MONSIEUR GEORGE DU BOUSQUET, whose name is so familiar amongst railway engineers, obtained his degrees as Mechanical Engineer at the Ecole Centrale in Paris, which he left in 1862, to become draughtsman at the works of the Northern Railway of France at Fives, near Lille.

MONSIEUR GEORGE DU BOUSQUET.

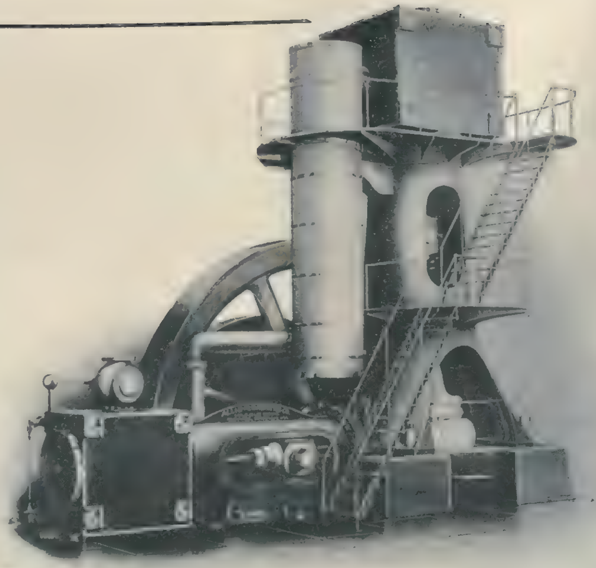
The late chief engineer of these works, M. Ferdinand Mathias, was not long in discovering that in M. du Bousquet he had an assistant of no small value, and this, no doubt, induced him to take a direct personal interest in the training of the young engineer. Seventeen years later, on the 20th October, 1883, when M Mathias was appointed Locomotive Engineer of the Company in Paris, M. du Bousquet succeeded him as Manager of the Works at Fives, and in September, 1888, when the Chief Mechanical Engineer of the Company, M. Edouard Delebecque, was unfortunately killed by an engine whilst crossing the lines at La Chapelle, M. Ferdinand Mathias got the appointment of Ingénieur en Chef du Matériel et de la Traction of the company, and immediately called M. du Bousquet from Fives to Paris, with the title of Principal Mechanical Engineer of the Works at La Chapelle.

On the 19th September, 1890, M. Mathias having died, M. G. du Bousquet was appointed to his present post as Chief Mechanical Engineer both for Locomotive and Carriage Departments. It is in that position that he undertook the heavy task of facing the constant demand made upon him of building engines of greater power and speed, both for passenger and goods trains. It is hardly necessary to recall the splendid performances of the du Bousquet engines on the Northern Railway of France and the magnificent corridor trains designed by M. du Bousquet, which are so much appreciated by the numerous travellers to Paris *via* Calais.

The most recent practical tribute paid to the genius of this distinguished engineer has been the introduction of one of his de Glehn compound locomotives into this country for use on the Great Western. This type of engine has been ably dealt with, in these columns, by Mr. Rous-Marten, who reverts to the subject in the present number (page 457). Its performances are, of course, being most carefully watched, and in the April issue of PAGE'S MAGAZINE it was shown that they have so far entirely sustained the opinions of those who were responsible for the experiment.

M. du Bousquet is Officier de la Légion d'Honneur, a distinction most deservedly bestowed upon him by the French Government in 1900.

POWER AT THE WORLD'S FAIR.



5,000-H.P. ALLIS-CHALMERS' ENGINE AND GENERATOR.

BY OUR ST. LOUIS CORRESPONDENT.

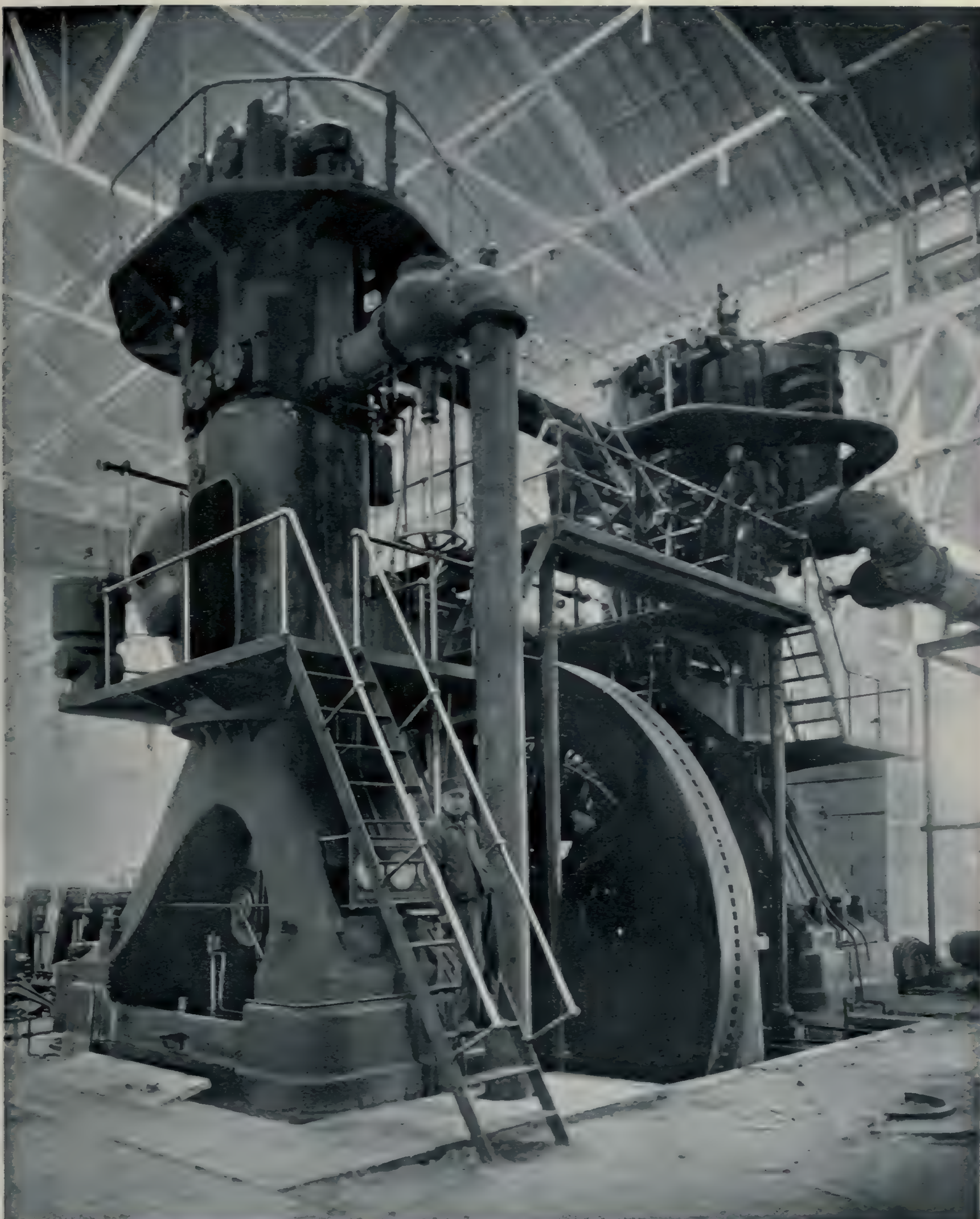
In previous issues of PAGE'S MAGAZINE we have dealt from time to time with the progress of the World's Fair. In the following pages will be found a brief account of those portions of the Exhibition which are more particularly interesting to engineers. The accompanying photographs were courteously furnished at our request by Mr. Mark Bennitt, Superintendent of the Exhibition Press Bureau.—ED.

IN the Palace of Machinery at St. Louis, and covering an area of 200,000 square feet—which is about the size of a city block—is the installation of engines, condensers, moving machinery, and other accessories, making up the 50,000 h.p. plant of the World's Fair.

There is a 5,000 h.p. reciprocating vertical and horizontal steam engine, which, with its base, has a total height of 54 ft., 20 of this being depressed below the level, and the remaining 34 elevated above the floor. This engine and its generator weigh over 500 tons, and their value approximates $150,000. There is a 1,750 h.p. gas engine from Tegel, Germany; a 600 h.p. high-speed engine from Harrisburg, Pa.; a 750 h.p. medium-speed steam engine from Cincinnati; and a 1,000 h.p. slow-speed steam engine from Burlington, Ia. There is a tangential water-wheel, from San Francisco, and a steam pump from Jeanesville, Pa., which causes the water-wheel to operate by forcing water through a pipe and nozzle at the rate of 1,200 gallons per minute. Under a pressure of 300 lb. to the square inch, this great volume of water strikes the buckets of the wheel, transmits its energy, and falls as quietly as if poured from a basin. This water-wheel makes 900 revolutions per minute, is regulated by a speed governor from Boston, and a meter from Providence regulates the flow. There are a 3,000 h.p. gas engine from Seraing, Belgium; an 8,000 h.p. steam turbine from New York; and a 5,000 h.p. steam turbine from Pittsburg, Pa. In the Machinery Palace, near the western end, are also four 3,000 h.p. reciprocating steam engines, and three 80 h.p. exciter sets.

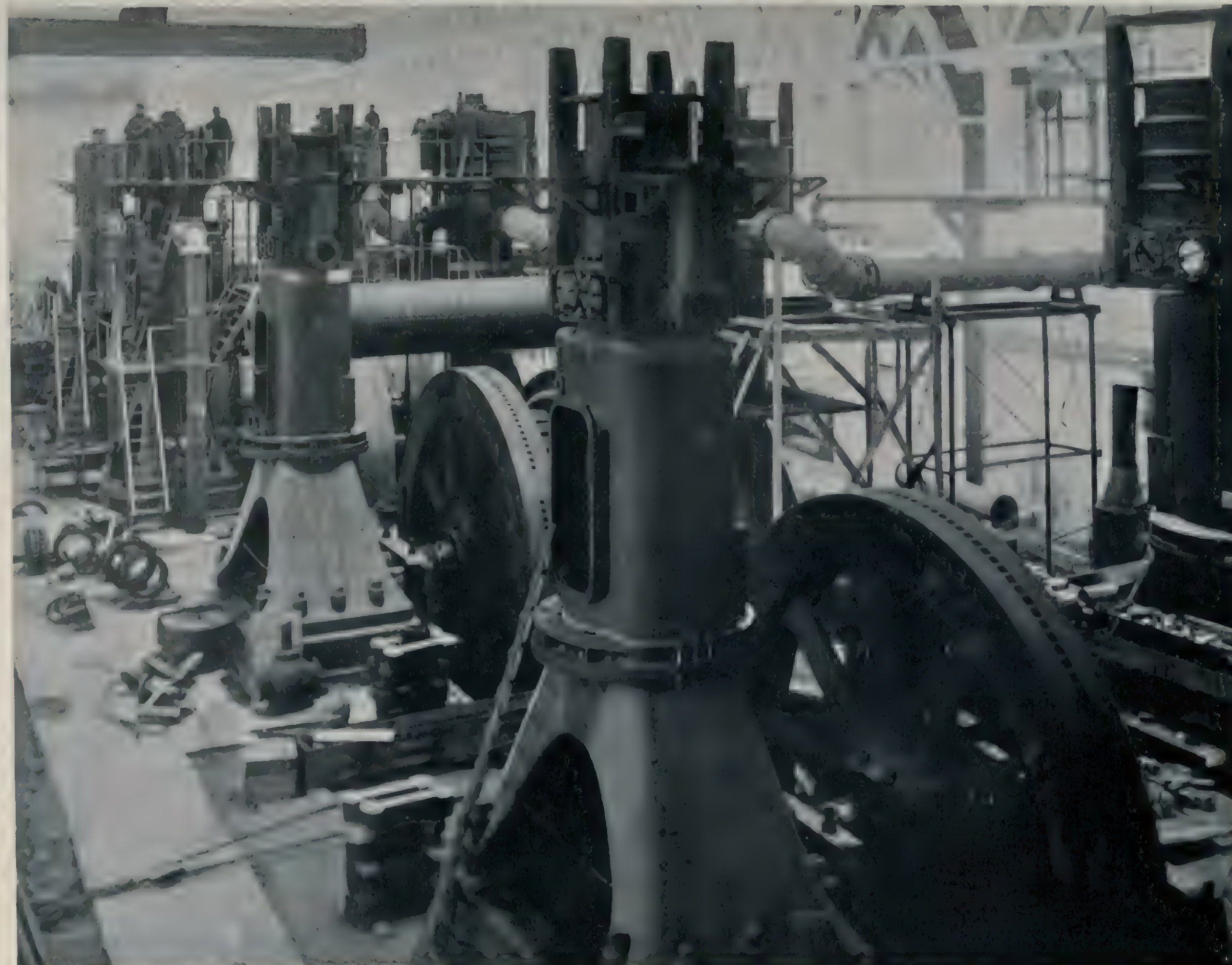
Such a line of prime movers has never before been brought together, yet this is but one of the three lines installed in the western half of Machinery Palace. The line of the north consists of steam engines largely of European build, and drawn from the greatest works in England, France, Germany, and Sweden. The line to the south, for the main part, is made up of gas and oil engines—the products of the great machine shops of the world. All types, speeds, and sizes are shown, from the little ½ h.p. gas engine for domestic use, to the great 8,000 h.p. steam turbine for the operation of lighting plants and trolley railroads.

The Belgian gas engine is a wonderful achievement.



3,000-H.P. WESTINGHOUSE GENERATOR—WORLD'S FAIR POWER PLANT.

PART OF BLOWER INSTALLATION IN STEAM, GAS, AND FUELS BUILDING—300 FT. BY 350 FT.



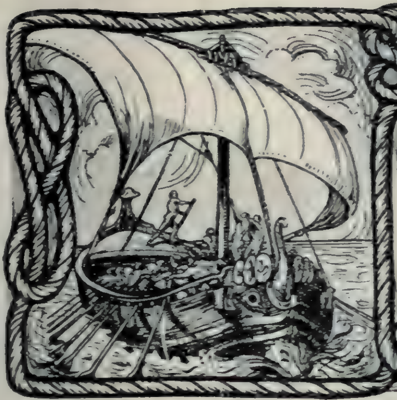
A LINE OF FOUR 3,000-H.P. WESTINGHOUSE GENERATORS AT THE WORLD'S FAIR.

No one has ever seen a gas engine of anything like 3,000 h.p. The same builders exhibited a gas engine of 600 h.p. at the Paris Exhibition of 1900, which excited more interest and comment than any other individual item at the Fair. Here we have one with five times the capacity of the Paris engine. Its fly-wheel weighs 34 tons, has a diameter of 28 ft., and its rim travels at the rate of nearly a mile and three-quarters per minute. A medium-sized horse can be driven through its cylinders, and its two pistons each travel 10 ft. at every complete stroke, making 100 strokes per minute each. About 30 tons of coal per day are consumed in the generation of the gas to operate it. The gas engines exhibited at the Chicago Exposition were mere toys compared to this engine.

One hundred feet to the west of Machinery Palace is found the Steam, Gas and Fuels Building, which covers an area of 100,000 square feet, and is a model fireproof structure. Here are mammoth hoppers for storing the 4,000 tons reserve supply of coal, and one can see the mechanical means for automatically conveying this coal from the cars to the bunkers, and from the bunkers to the furnaces and gas plants. The total length of the automatic conveyor lines is about three-quarters of a mile. The daily consumption of coal exceeds 400 tons. Here are found mammoth marine boilers from Germany and France, of the types used in the battleships of those countries. Gas producers to supply gas for the operation of the engines in the Machinery Hall are in this building, and there are various types of mechanical stokers, forced drafts apparatus, water purifiers, and other appliances germane to steam generation.

In its entirety, the power plant of the Exposition exemplifies and demonstrates the most modern practice as it obtains in the United States and in Europe.

PALACE OF MACHINERY AT THE WORLD'S FAIR, ST. LOUIS.
It occupies an area of 525 ft. by 1,000 ft. and contains the 50,000-h.p. plant of the Exhibition.



THE STORY OF THE CUNARD COMPANY.

BY

BENJAMIN TAYLOR, F.R.G.S.

In the previous article the early history of the Cunard Company was related. The author now records the unsuccessful attempts which have been made from time to time by various competitors to secure supremacy on the Atlantic, and deals with the most recent developments of the Company.—ED.

II.

THE formation of an American Combine, competing for the Transatlantic traffic, recalls the efforts which the Americans made in past years to secure a share of this trade. The Cunard Company were, of course, the first to establish a regular service of mail steamers between the Eastern and the Western hemispheres. This was, as we have seen, in 1840, but although they long enjoyed a practical monopoly, they were always exposed to occasional competition. There were "tramps" in those days, as in these.

THE FIRST ORGANISED OPPOSITION.

The first organised opposition, however, was of American origin—the Ocean Steam Navigation Company, formed in the United States in 1847. This Company had two steamers built—the *Washington* and the *Hermann*—and they contracted with the U.S. Government to carry the mails twice a month between New York and Bremen in return for a payment of £40,000 a year. The steamers were to call at Southampton on both runs, and the contract was worked out for a year, but was never renewed. The *Washington* was the first to run, and she left New York in June, 1847, for Southampton, on the same day that the Cunard steamer, *Britannia*, left for Liverpool. The Cunarder came in two days ahead of the American. The *Washington* was of 1,750 tons measurement, and 2,000 horse-power, and this is what a *Times*' reporter of the day (June, 1847) said about her, as he described her appearance in the Solent: "In point of size she looked like an elongated three-decker, with only one streak round her; but about as ugly a specimen of steamship-building as ever went through this anchorage. She did not appear to make much use of her 2,000 horse-power either, but seemed rather to roll along than steam through the water. She excited considerable curiosity, although her performance, as compared with the *Britannia*, had evidently taken the edge off the feeling with which the vessel would have been viewed had a different result been obtained in her favour."

This Ocean Steam Navigation Company is said to have been the first case in which national funds in America were applied to the support of private enterprise. Congress did not very readily grant the subsidy, and was only induced to give it as a helping towards the formation of a reserve marine force, which, in case of need, would be available for the protection of American rights. In the early contracts between the British Government and the Cunard Company for the conveyance of mails between New York and the Bermudas, there was a provision that the steamers should carry one or two eighteen-pounders. The *Washington* and *Hermann* were the wrong type of vessel. Their competition was not a success, and when the contract was up they were laid aside.

OTHER RIVALS—THE GUION LINE.

About this time a new opposition to the Cunard Company was the germ of the Guion Line. The Black Ball Line of sailing packets between Liverpool and New York was one of the most famous of its day and generation, and the managing owners of the Black Ball Line were C. H. Marshall and Co. The owners of these clippers were among the first to recognise that their days were numbered, and that steam would rule the waves in future years. About the year 1847, C. H. Marshall and Co. had a steamer called the *United States* built, to carry the Black Ball flag, and to secure some of the sweets of the Atlantic steamer traffic for their own line. She did not pay, and was soon taken off the service, but the Black Ball fleet was eventually united with the sailing fleet of Mr. S. B. Guion, who, about 1866, began to organise the regular service of steamers known as the Guion Line.

THE NEW YORK AND HAVRE STEAM NAVIGATIO COMPANY.

The next rival of the Cunard Company was the New York and Havre Steam Navigation Company, which also was a concern subsidised by the United States

A TYPICAL SCENE AT THE LIVERPOOL LANDING STAGE.

Government. This Company undertook a contract for fortnightly mails between New York, Southampton, and Havre for a subsidy of £30,000 per annum, but they began badly. Their first two steamers were wrecked, and two steamers they chartered, until new ones could be built, proved a loss. Finally, they got the *Fulton* and the *Arago* on to the run, but by this time the Collins Line was in full swing, and the New York and Havre Company disappeared.

The Americans were chagrined to see their supremacy on the Atlantic passing away, and the conveyance of mails and passengers becoming the monopoly of an English company—or rather a Scotch company, for what capital was in the Cunard Line was mainly Scottish. North American clippers were of no avail against steamers, and steamers could not be run with profit without Government subventions. This, at any rate, was the belief then, although the very success of the Cunard Company—at that time earning something like £7 10s. per ton freight on the goods carried by their steamers—proved the contrary. Moreover, the national pride of Brother Jonathan was aroused. He did not like the idea—apart altogether from profit—of his oversea, and even coast-mail, traffic being monopolised by the Britisher.

THE COLLINS LINE.

While the Cunard Company were expanding, American steamers were being launched in abundance on American rivers and lakes, and it was natural that a determined effort should be made to share the spoils of the Cunard Company, if not to run them off the face of the waters. The man for the occasion appeared in Mr. E. K. Collins, of New York, who had from boyhood been engaged in connection with clippers between that port and Liverpool. Mr. Collins saw all the profit disappearing in his packet business, and set to work to organise the Collins Line of steamers to replace the Collins Line of sailing packets. He had to secure the support of a number of American capitalists, and they were not disposed to move without promise of Government aid. The Government were willing enough to treat, and Congress was already committed to the principle of subsidies. The bargain was in fine made that Mr. Collins should provide five first-class steamers, sufficient for a service of twenty voyages per annum, and that he should receive 19,250 dollars, or £3,850, per voyage, from the Government. These were better terms than the Cunard Company started with—£55,000 per annum for a fortnightly service with three steamers. The Cunard subsidy was afterwards increased to £70,000 for four steamers, but there were certain stringent conditions as to sailing dates, the carrying of Naval officers, etc., which were very irksome. On securing the Government contract, Mr. Collins and his partners set to work to build four wooden steamers of 3,000 tons each, and 800 horse-power, steamers nearly three times the tonnage and twice the horse-power of the first four Cunarders. They were strongly built of oak, planked with pitch pine, strengthened with iron bands and fitted with all the latest improvements of their day. There is no doubt the *Arctic*, *Baltic*, *Atlantic* and *Pacific* were very superior vessels, remarkable not less for the beauty of their models than for the excellence of their construction, which cost 700,000 dollars each. Their dimensions were: Length of keel, 277 ft.; length of main deck, 282 ft.; depth from main deck, 24 ft.; breadth of beam, 45 ft.; launching draught aft, 10 ft.; area of loadline, 9,369·10 square feet; weight of hull, 1,525 tons; weight of spars and rigging, 34 tons; ordinary loadline, 20 ft. aft and 19½ ft. forward. They had each three masts, three decks and an orlop deck, and rounded sterns. The hulls were built by W. H. Brown and Co., of New York, and the engines and boilers were designed by Mr. Sewell and Mr. Faron, chief engineers of the U.S. Navy. As speed in excess of the Cunarders was required, cylinders of 95 in. diameter and 9 ft. stroke were designed—the *Britannia's* cylinder being only 72½ in., with a 6 ft. 10 in. stroke. The Collins' engines were on the side-lever principle, with cast-iron beams and wrought-iron columns and braces. The boilers were peculiar, and were the invention of Mr. Faron. The furnaces were constructed for bituminous coal, but after a while anthracite was used on the eastward runs. The diameter of the side-wheels was about the same in each of the four boats—viz., 35 ft., 35 ft., 35½ ft. and 36 ft. respectively.

LAVISH EXPENDITURE ON SPEED, COMFORT, AND ELEGANCE.

The *Arctic*, the first of the Collins' fleet, made the following average record with her engines: Pressure, 16·9 lb.; revolutions, 15·8 per minute; consumption of coal (anthracite), 83 tons per day; average speed, 316 knots per day. Her maximum record was: Pressure, 17·5 lb.; revolutions, 16·7 per minute; consumption, 87 tons; speed, 320 knots per day. The *Asia*, of the Cunard line, consumed 76 tons of coal on a run of 303 knots per day. The *Pacific* was the most popular of the Collins' fleet, because her great height above water, straight bows, and clear upper deck, made her more roomy and comfortable for passengers. The Collins Company aimed not only at speed—on which, indeed, the U.S. Government subsidy depended—but also at surpassing in comfort and elegance all provisions hitherto made for ocean passengers.

These were the first steamers to provide smoking rooms. They also provided dining saloons, in addition to the general saloons hitherto thought sufficient—apartments of 60 ft. by 20 ft., gorgeously upholstered and fitted with ornamental woods. With them began the era of Turkey carpets, marble-topped tables, gilded mirrors, painted panels, and costly lounges. They also inaugurated the barber's shop, that permanent and indispensable institution now in all well-appointed ocean liners. Naturally, therefore, the Collins' steamers excited a great deal of interest, even before the exciting series of races with the Cunarders had fairly begun.

But they cost much more money than was anticipated when the enterprise was started. Expenditure on hull, machinery, and equipment was lavish, and long before the fleet of four was completed the company had practically exhausted their capital, and had to apply to Government for an advance in anticipation of the subsidy. The company were relieved from the obligation to furnish a fifth steamer on guaranteeing a higher rate of speed than that at first stipulated for the four. There were to be twenty-six sailings per annum, and the subsidy was raised to 33,000 dollars per voyage. This made a total subvention of 858,000 dollars, or £171,600 per annum. But the probable effect of the enlarged competition on traffic was not kept in view, and one very pronounced effect was, that whereas the Cunard Company had been receiving £7 10s. per ton freight, soon after the Collins' steamers started the rate fell to £4 per ton.

The Collins Company claimed, and with some justice, that they cut off a day and a half in the voyage between New York and Liverpool. But the tremendous exertion cost them a million dollars per annum, which was not recouped by the stream of passengers they attracted from the Cunard boats—and in 1852 they really carried about one-half more than did the Cunard.

From 1850 to 1852 the Collins Line had the pull, but in 1852 the Cunard Company brought out the *Persia*, the largest and most powerful vessel as yet placed on the Atlantic, and two or three years later another steamer, with which they completed the conquest of the Collins Line.

MISFORTUNES OF THE COLLINS COMPANY.

It was not only competition which upset the Collins Company. Misfortune dogged their steps otherwise. The first crushing blow to the struggling undertaking was the loss of the *Arctic*—one of the first and saddest of the catastrophes of the Atlantic steam passenger trade. The *Arctic* left Liverpool for New York on September 21st, 1854, with 150 first-class passengers, 83 second-class, and a crew of 135 men—say 368 souls, all told. Six days later she was sixty miles off Cape Race. In a fog she collided with the French steamer *Vesta*, bound from Havre, with 147 passengers and a crew of fifty. At first the *Vesta* seemed to have had the worst of it. Some of her people scrambled on board the *Arctic* before she sheered off, others rushed to the boats, which, in the hurry, were swamped with all on board of them. Those who remained on the *Vesta* were saved, for she reached St. John's. The *Arctic* was badly hit somewhere below the water-line, and the water was making its way to the engine-room. She was at once headed round for Cape Race, but before she could make land the water reached the fires, and the ship went down. Of the boats which were hastily launched, only two were ever heard of again, and these succeeded in reaching the shore with fourteen of the passengers and thirty of the crew, including the captain and two officers who stuck by the ship to the last. Among those who went down with the *Arctic* were the wife, son and daughter of Mr. Collins, and numbers of persons of eminence in commerce and society on both sides of the Atlantic. The catastrophe caused a sort of check to the boom in ocean travel, and started a brisk discussion on the dangers of speed, the risks of cross-sea traffic, the build of steamers, and so on.

The excitement had barely died down, when a second terrible disaster befell the Collins Line, and gave a further fright to passengers. This time it was the *Pacific*, the pioneer and the most popular member of the Collins' fleet, although the *Arctic* was the fastest, and was esteemed the finest of the sisterhood. And the second catastrophe occurred within a year of the loss of the *Arctic*. The *Arctic* was lost in September, 1854. On June 23rd, 1855, the *Pacific* left on the same voyage—from Liverpool to New York—and was never heard of again. Her complement of passengers was much smaller than that of her unfortunate sister ship, viz., twenty-five first-class, and twenty second-class, with officers and crew numbering 141 besides—in all, 186 souls. She had the mails, and her cargo was insured for £500,000, but was doubtless worth a great deal more. How the *Pacific* was lost was never revealed. Not a soul was saved, and not a vestige of her was ever cast upon the bosom of the waters, or upon any lonely shore.

The loss of these two ships was a terrible blow to the Collins Company, but they set to work to raise more money in order to build two new steamers, to excel in size and speed and everything, not only the four first, but also the Cunard's *Arabia*. The *Adriatic* was the only one of the new additions which made any record. This new competition began in 1856, but it only lasted for two years. The Collins Company were running at a ruinous loss, and in 1858 the funds gave out. There was a strong effort to reconstruct the company with fresh capital, but a dead set against subsidies was made, and Congress refused to grant a renewal of them.

The collapse of the Collins Company removed American competition for the time being, but did not leave the ocean to the monopoly of the Cunard. American steamers of the Vanderbilt Line continued to run between New York and Havre, with varying success, until 1868.

THE INMAN LINE.

The fall of the Collins Line was the signal for the rise of the Inman Line. For some years the Liverpool, New York and Philadelphia Steamship Company, started by Mr. William Inman, had been running regularly between Philadelphia and Liverpool, but so long as the Collins and Cunard boats were racing each other for the New York traffic, the Inman boats did not interfere in that, and carefully avoided New York—at least, until the year 1857, which was just prior to the break up of the Collins Line. When that concern was fairly out of the way, Mr. Inman took up their sailing dates and sent his steamers regularly between New York and Liverpool, as well as between Philadelphia and Liverpool. The death of the Collins Line was thus the new birth of the Inman, and the Inman Company were the first to put on iron screw steamers for the Transatlantic traffic. To Mr. Inman belongs the credit of discovering that the propeller was the most suitable form of steamer for ocean service.

Mr. George Burns was created a baronet by the late Queen Victoria in 1889. He was then an old man, retired from business, and he lived only till 1890. Then he was succeeded by his son John, who was created first Lord Inverclyde in 1897, and died in 1901. It was he who organised the transfer of the business of the old Burns and MacIver firms to the Cunard Steamship Company, Ltd., which was registered in 1878 with a capital of £2,000,000, in shares of £20 each, of which 60,000 are fully paid and 40,000 have £10 paid on them. The first Lord Inverclyde was the first chairman of this company. His eldest son, the present Lord Inverclyde, is the second chairman, and it is he who has organised the recent new departure of the company.

THE CUNARD AND THE GOVERNMENT.

The acquisition by an American Combine under Mr. J. Pierpont Morgan of a number of British lines of steamers on the Atlantic led to negotiations between the Government and the Cunard Company, which resulted in an agreement intimated in a circular by Lord Inverclyde to the shareholders in the following terms: "I have now the honour to inform you that I have concluded negotiations with His Majesty's Government, on behalf of the Cunard Company. The following are the principal terms of the arrangement :—

"1. The Cunard Company are to build two large steamers for the Atlantic trade of high speed.

"2. The agreement is to remain in force for twenty years from the completion of the second of these vessels.

"3. The Cunard Company pledges itself, until the expiry of the agreement, to remain a purely British undertaking, and that under no circumstances shall the management of the company be in the hands of, or the shares or the vessels of the company held by, other than British subjects.

"4. During the currency of the agreement the Cunard Company is to hold at the disposal of the Government the whole of its fleet, including the two new vessels and all other vessels as built, the Government being at

PROMENADE DECK OF THE "CAMPANIA."

FIRST SALOON SMOKING-ROOM, "SAXONIA."

liberty to charter or purchase all or any such vessels at agreed rates.

"5. The Cunard Company also undertakes not to unduly raise freights, or to give any preferential rates to foreigners.

"6. The Government are to lend the money for the construction of the two new vessels, charging interest at 2¾ per cent. per annum. The security for the loan is to be a first charge on the two new vessels, the present fleet, and the general assets of the Cunard Company.

"7. The Cunard Company is to repay the loan by annual payments extending over twenty years.

"8. From the time the new vessels commence to run the Government are to pay the Cunard Company at the rate of one hundred and fifty thousand pounds (£150,000) per annum, instead of the present Admiralty subvention.

"A meeting of the shareholders will be convened as soon as practicable for the purpose of obtaining their approval to such alterations in the articles of association as will be required to enable the directors to enter into a formal agreement embodying these terms."

According to the specifications issued by the Cunard Company the length of the new liners is to be 750 ft., or fifty feet longer than any vessel as yet afloat. The beam of 76 ft. is one foot greater than that of the largest of the White Star Company, and compares with 72 ft. in the *Kaiser Wilhelm II.*, 68 ft. in the *Oceanic*, and 67 ft. in the *Deutschland*. The new Cunarders will be of between 28,000 and 30,000 tons displacement, as against the *Celtic*, 20,904; *Kaiser Wilhelm II.*, 20,000; *Oceanic*, 17,274; and *Deutschland*, 16,502. In the German vessels the highest engine power is 40,000, enabling them to steam at an average speed of rather over 23 knots an hour. The Cunarders' *Campania* and *Lucania* have engines of 28,000 i.h.p. and a speed of 22 knots. The new liners will probably have engines of about 58,000 i.h.p., to attain a speed of 24 to 25 knots.

UPPER PROMENADE, "SAXONIA."

THE NEW SUBVENTION.

Concerning the amount of the new subvention, about which there has been a good deal of foolish talk on both sides of the Atlantic, it will be well to quote from the report of the Admiralty Committee appointed to inquire into the whole subject of merchant cruisers. They say: "We have inquired carefully into the initial cost of vessels possessing a speed of 20 knots and up to 26 knots, and also into the amount of annual subsidy which would be required by a commercial company towards making good the loss which would be sustained in peace time by running such vessels. These costs may be provided either by (1) the Admiralty guaranteeing a sum representing the first cost of each ship, thus enabling a shipowner to raise the capital at 3 per cent., instead of 5 per cent., which he would otherwise have to pay; (2) the contribution on the part of the Admiralty of a lump sum towards the first cost of the ship, thereby reducing the outlay on the part of the shipowner; (3) an annual payment extending over an agreed period of years. Adopting the principle of an annual payment, we subjoin in a tabular form our estimates of the first cost of ships having a speed of from 20 to 26 knots, and of the subsidy which we believe will be found necessary:—

Average Ocean Speed. Knots.	First cost, Building, &c. £	Engine Power, I.H.P.	Annual Subsidy. £
20	350,000	19,000	9,000
21	400,000	22,000	19,500
22	470,000	25,500	40,500
23	575,000	30,000	67,500
24	850,000	40,000	110,500
25	1,000,000	52,000	149,000
26	1,250,000	68,000	204,000

It is possible that hereafter the first cost of such ships and their running cost may be diminished to some extent by inventions for using oil fuel, turbine engines, etc., etc.; but for the present purpose these cannot be taken into consideration."

The subvention for the two new Cunarders is, therefore, just what the Committee estimated would be necessary to recompense *one* of the speed specified.

One difficult point to decide was, whether the new vessels should be propelled by two or three screw propellers. Two propellers would require four engines —two on each shaft, as in the case of the 40,000 i.h.p. sets of the new German ship *Kaiser Wilhelm II.* There is the difficulty of transmitting such an enormous power through two shafts. It means 25,000 h.p. for each, and although the Cunard Company's *Umbria* and *Etruria* have single screws with 14,000 to 15,000 i.h.p., it is a long step even from the German 19,000 to 20,000 to the 24,000 to 25,000 i.h.p. of the new Cunarders. In the German ship the shaft for each engine is 226 tons. The six-throw crank is of nickel steel, which has a breaking strain of 38·41 tons per square inch, with an elongation of 21 per cent., and weighs in all 114 tons. The propeller shaft is of crucible steel. The ingot for it weighed eighty tons, and was cast with the contents of 1,768 steel smelting crucibles, the operation occupying 490 men during thirty minutes. The alternative to two shafts is three screws, each with its own engine, which would divide up the power to about 17,000 i.h.p., but an arrangement requiring much more engine room, as three engines cannot well be placed in the width of the ship along with auxiliary gear. A special commission of experts appointed by the Cunard Company have just decided that the turbine should be adopted, and that four shafts and four sets of turbines should be preferred to three.

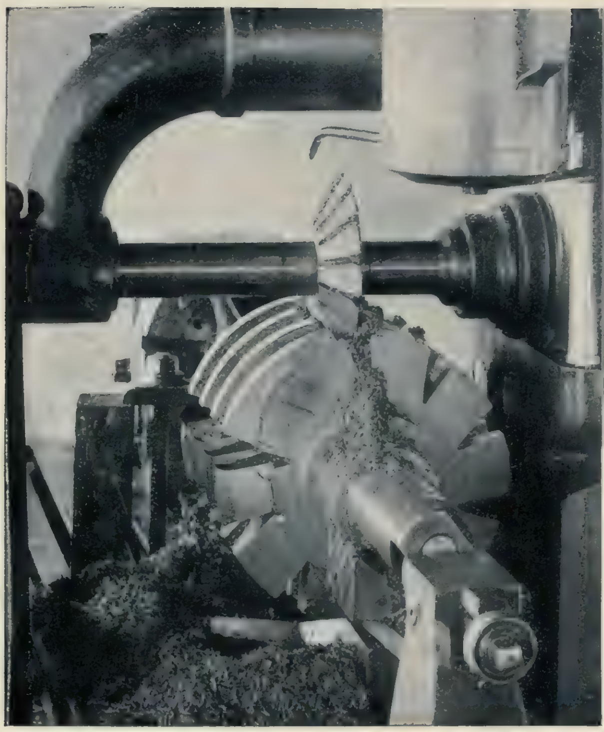
THE LATEST CUNARDERS.

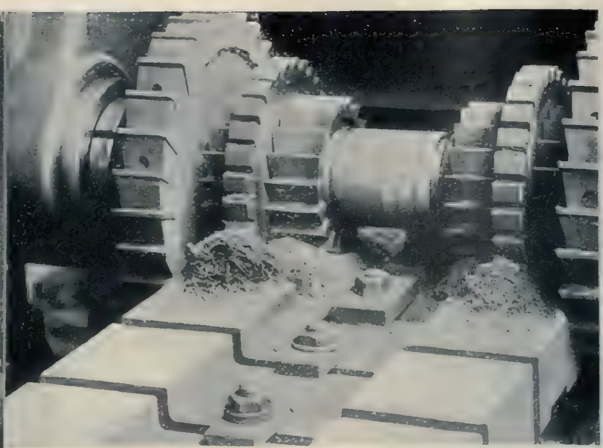
There has been necessarily a good deal of delay in placing the contracts for these two mammoth vessels, concerning which Lord Inverclyde said in 1903 at the annual meeting of the shareholders: "These steamers will, of their kind, be the biggest thing which has yet been done in the world, and we have, therefore, desired to give the utmost care and consideration to every point before we definitely place the order with any one. It has not been time wasted, and we have had the benefit of the advice of some of the best experts in the country in many matters. As you will very well understand, even those of you who have the least acquaintance with these matters, there is a vast amount of detail which requires to be thought out in connection with these steamers, especially as I can safely say that no shipbuilders were prepared, when we first went to them, to undertake straight away the building of such ships as we required. The best dimensions for the ships, their internal arrangements, the placing of their weights, their draft, their engine power, and many other details, have required the greatest thought and care. I have the utmost confidence in what the result will be, and I am sure that time given now in thinking out these things is of the utmost value in the long run, and that we shall feel that we have left no stone unturned in endeavouring to design two perfect ships, which will, I trust, not only give satisfactory results to our shareholders, but will be such ships as both the company and the country will be proud to own."

"AN ENTIRELY BRITISH COMPANY."

And to preserve the Cunard Company as an entirely British company an alteration has been made by resolution of the shareholders in the articles of association. These now include clauses specifying that it is to be regarded as the cardinal principle of the company that it is to remain under British control, and accordingly that no foreigner shall be qualified to be a director or principal officer of the company, and no share shall be held by or in trust for, or be in any way under the control of any foreigner or foreign corporation, or any corporation under foreign control. The expression "foreigner" is to mean any person who is not a British subject, and "foreign corporation," any corporation not established under and subject to the laws of some part of His Majesty's Dominions, and having its principal place of business in those Dominions. New clauses have been adopted requiring a declaration of nationality in share transfer transactions, and empowering the directors to enter into any agreement with the Government as to carrying mails, building vessels, placing the fleet at the disposal of the Government, whether by sale, hire, or otherwise, with power to issue to any nominee of the Government a share or shares of the company, carrying such voting power as the directors may think fit. To the capital of the company is added a new share of £20, called the "Government share," and only to be issued to a nominee or nominees of the Government, with a controlling vote only on points relating to national policy. These changes are the outcome of the agreement with the Government in connection with the new fast steamers, and constitute a sort of unique alliance between the State and a commercial company.

MARCONI INSTRUMENT ROOM.





FACTS ABOUT HIGH-SPEED TOOL STEELS.

BY

J. M. GLEDHILL.

The following abstracts are from a very complete paper on high-speed steels, read by the author before the Coventry Engineering Society. Specimens of the more important alloys used in the manufacture were exhibited, and the samples of work produced by high-speed steel were remarkable for their excellent finish and accuracy. For the accompanying illustrations we are indebted to Sir W. G. Armstrong, Whitworth, and Co., Ltd.—ED.

THE development of high-speed steel during the last few years has revolutionised alike the theories and treatment of tool steel, as well as its uses in our engineering shops. In proof of this it need only be considered that we have the paradoxical condition that whereas it was formerly necessary above all things in treating self-hardening steel, that every care should be taken not to over-heat it, that is to exceed a temperature of between 1,500° and 1,600° F., otherwise its nature and cutting power would be seriously impaired, now it is one of the essential conditions to heat up the high-speed steel very considerably above these temperatures; in fact to so high a temperature as 2,200° or 2,300° F., that is, a temperature which would practically melt pig iron. This is a truly remarkable paradox, and forms one of the most striking phenomena in the recent history of steel treatment.

Partly as a result of this it is now possible with high-speed steel to turn and machine steel at a rate up to 400 ft. per minute, and also to drill cast-iron at 25 in. per minute! These are indeed remarkable speeds when it is remembered that only a comparatively short time back with the ordinary crucible steels a cutting speed of 30 ft. to 50 ft. per minute was more like the limit.

RISE AND DEVELOPMENT OF HIGH-SPEED STEEL.

It is to Messrs. Taylor and White, of America, that the credit of initiating high-speed cutting is due, and who, some few years back, showed what was then considered to be some remarkable cutting speeds. It will, however, not be denied that the improvement and development beyond their process that has taken place during the past few years is due to our own country, for whereas in the Taylor-White process their steel could not be sent out in bars, but only in the form of finished tools specially treated on the nose only, now high-speed steel, manufactured in this country, is delivered to users in the ordinary way, and further, its forging and treatment is absolutely simple, in fact, simpler, and is accompanied by less risk than in the case of ordinary tool steel. The English manufacturer is even exporting high-speed steel on a large scale to America.

In forging, annealing, and hardening crucible steels it is essential that the most suitable temperatures should be found for all of these processes, and then accurate means be taken to ensure such temperatures being actually obtained as near as practically possible. This can only be effected by the skilful use of pyrometers or other scientific heat-recorders, for to work on the old-fashioned lines of judging by the eye is no criterion of actual temperature, and is no longer advisable. It is now known that every composition of steel has its own definite temperature that is best suited for obtaining from it the most satisfactory results, and the nearer this can be worked to the better, any deviation from the correct temperature, up or down, involving a corresponding difference in the efficiency of the steel.

SOME OF THE MYSTERIES OF STEEL

On the question of heat-treatment of steel, it is indeed remarkable what divergent effects different temperatures of heating produce on its molecular structure. To look at a bar of steel lying on the ground, one can scarcely believe that it contains as much mystery and complexity as human nature itself. For example, a bar, if it be heated to a certain degree of temperature, may be left in such a molecular condition as to be considered useless and thrown aside as such. Heated up a little higher, its structure is completely altered, the bar attains a good condition, and is capable of standing great tenacity and ductility. Again, if we take another bar of steel of certain composition, we may heat it to a certain temperature when its molecular structure will be such that it can be cut and shaped into any desired form; but go a step further, and heat this bar to a still higher temperature, and rapidly cool it, its molecular condition has again changed. The bar has become intensely hard, and is capable of cutting softer steels—it has, in fact, become tool-steel. If the steel is heated to a still higher temperature, it is in ordinary phraseology termed burnt, and if you then rapidly cool it, the steel is still hard, but its structure becomes granular, and therefore very brittle. Its tough nature and cutting powers have become impaired; in fact, its molecular structure is again changed.

It will therefore be seen how important it is in heating steel all respect should be paid to temperature, in order to get out of it all its inherent qualities. One can imagine a bar of steel saying to those about to treat it, "Heat me properly, and I will serve you well; but heat me badly, and I will abandon you."

It has been stated by some that there is not much advantage in its use, but it is easy to prove very greatly to the contrary. There is nothing like facts in proof of statements, and the author does not only give the results of his own firm, but is greatly indebted to many important engineering firms all over the country using "A.W." high-speed steel for much information as to actual daily practice now existing in their workshops.

ECONOMY OF HIGH-SPEED STEEL.

It is also proved beyond doubt that it is distinctly economical to use high cutting speeds, this being clearly shown in the conclusions arrived at by the Manchester Association of Engineers as a result of an exhaustive series of tests and trials with high-speed tool steel. These trials extended over a period of many months and were carefully carried out under the superintendence of Dr. Nicolson, Professor of Engineering at the Manchester School of Technology, together with a specially appointed committee, and the tests were of a very complete and detailed character.

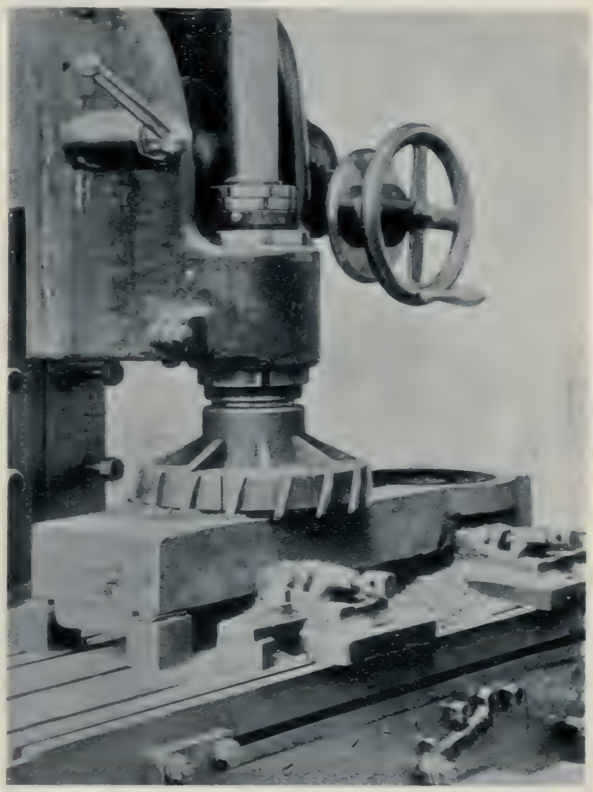
Briefly, some of the results arrived at by this committee were that although more power is naturally required to take off metal at a high speed than at a low speed, the increase of that power is quite out of proportion to the large extra amount of work done by the high-speed cutting. This, one would say is an important point for all users of steel to bear in mind. Of course, it cannot now be denied that machine tools which were fully equal to the cutting power of the old kinds of tool steels are now quite unequal to the capabilities of the high-speed steel—not in driving power alone, but in the absence of rigidity and general strength of working parts for obtaining the utmost work that the high-speed steel is capable of performing. Purchasers of machine tools will, doubtless, in obtaining new designs, note this, so that machines and tool steels which are going to be used in them should be, so to speak, approximately equated. Want of power and strength is undoubtedly being realised, and rapid strides are being made by the leading tool makers to bring their designs into line with the steel.

PRACTICAL TESTS.

A proof of this might here be given: We had at our works an ordinary 12 in. lathe, turning armour-plate bolts of from 4 in. to 5 in. diameter, and we thought we did wonderfully well in turning them at a cutting speed of 80 ft. per minute. We found the tool at the end of the day's work to be practically as good as at the commencement, and this caused an increase of speed to be suggested.

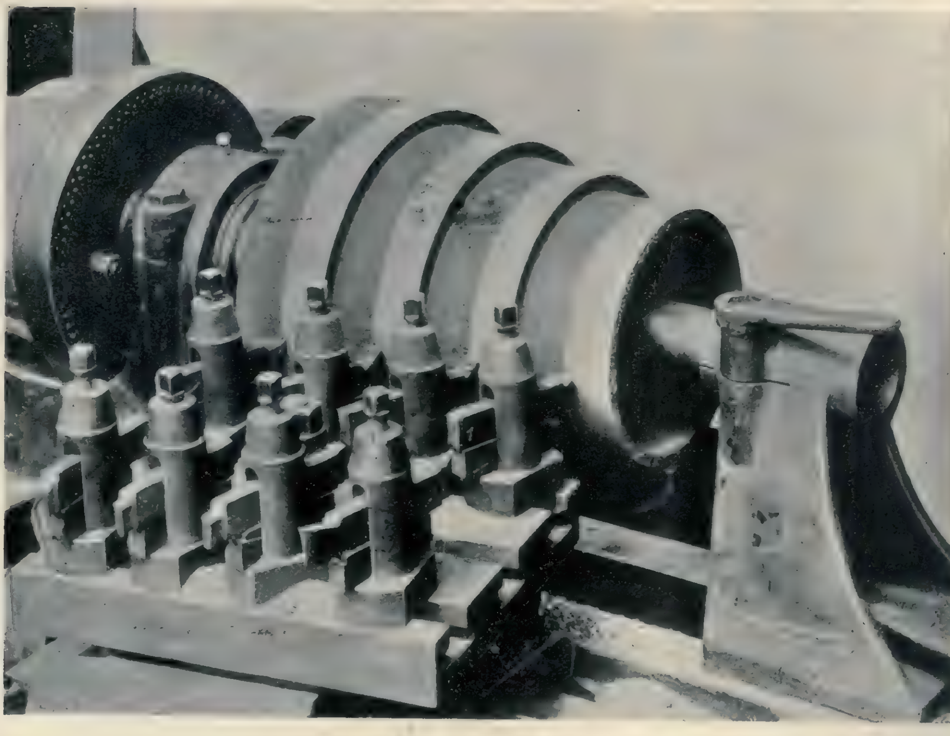
It was found, however, that the lathe had not sufficient power to admit of any increase of speed, and yet it was felt beyond doubt that if we could only get the required power we could run at double the cutting speed.

We therefore designed a special lathe with an increased width of belt from 4 in. to $7\frac{1}{2}$ in. width and



NO. 4. VERTICAL MILLING MACHINE BY MESSRS. ALFRED HERBERT, LTD., COVENTRY,

With face milling cutter 12 in. diameter, with 16 inserted teeth of "A.W." steel. Cutting speed 75 ft. per minute; depth of cut, $\frac{5}{32}$ in.; width, 11 in.; feed, 7·5 in. per minute.



TURNING CONE PULLEYS WITH HIGH SPEED STEEL.

The photo was taken while the lathe was cutting at a speed of 120 ft. per minute.

NEW LATHE FOR TURNING ARMOUR PLATE BOLTS WITH "A.W." STEEL.

One day's work is shown, consisting of 40 bolts. Cutting speed, 152 ft. per minute ; depth of cut, $\frac{3}{4}$ in. ; 32 cuts per inch. Total weight of metal removed, 2,480 lbs., only one tool of $1\frac{1}{4}$-square inch section being used.

an increase of the belt velocity of 400 ft. per minute. The lathe was duly put to work and we immediately began to cut at a speed of 152 ft. per minute, the same depth of cut and feed being maintained as when we were cutting at 80 ft. per minute, whilst the tool, which is $1\frac{1}{4}$ in. square in section, lasts from seven to eight hours without requiring to be re-ground. So much then for bringing up our machines to the limit of power of the steels.

Another excellent example of high-speed cutting by this steel may be cited: Turning oil-hardened gun-metal having a tensile strength of 40 to 45 tons per square inch, the cutting speed was 50 ft. per minute, eleven cuts per inch, whilst the depth of cuts varies from $\frac{3}{16}$ to $\frac{11}{16}$, the tool cutting nine hours without interruption.

There is another point raised by some users of high-speed steel, and that is as to its having been found brittle. This, however, is not the case, if the steel is properly hardened, and the hardening confined to the cutting area, and proper support be given to the tools when fixed in the machine.

PRESSURE-RESISTING POWERS.

One example may be given as showing the great pressure-resisting powers of high-speed steel. An "A.W." tool $1\frac{1}{4}$ in. square section, cutting a steel forging at 25 ft. per minute cutting speed, $\frac{7}{16}$ in. depth of cut, with a feed of $\frac{3}{8}$ in. per revolution, and removing $14\frac{1}{4}$ lb. of metal per minute, 855 lb. per hour, withstood easily the very great pressure, which such heavy cutting as this would put upon it, and without showing any signs of weakness. In practice for heavy cutting of this nature a tool of about 2 in. square section would be used; so that it adds further proof when looking at the small section of the tool employed. It may be added that a much higher speed than 25 ft. per minute could have been done if the lathe had had sufficient driving power.

Another example of the resistance of high-speed steel to shock is shown by a tool of $1\frac{1}{4}$ in. square section used for cutting the top and bottom faces of the webs of a large three-throw crank-shaft. The tool was worked for forty hours without being re-ground, the cutting speed being 40 ft. per minute, depth of cut $\frac{3}{8}$ in., and feed thirty-two cuts per inch, and, of course, it will be understood that the tool was not cutting continuously, but the web was coming on the tool intermittently.

HIGH-SPEED STEEL FOR MILLING.

A subject that must be of the greatest importance to all engineers is that of milling, as by the use of this method of working, a much greater output of production can often be obtained. By the use of cutters made of high-speed steel still greater economies are effected, for not only can higher cutting speeds be used than when using ordinary carbon steel cutters, but the cutters made from the former can be run for much longer periods without being ground, and as the grinding of milling and similar cutters is a comparatively costly operation, a further economy is thus effected.

In support of these statements, a few results may be submitted taken from the daily practice at our works. A pair of straddle mills 7 in. diameter, and $1\frac{1}{2}$ in. wide, made of "A.W." steel were used to cut a $\perp$ (an inverted Tee section) section from bars of forged steel 7 ft. 3 in. in length, each cutter taking a cut $1\frac{1}{2}$ in. deep, and $\frac{9}{16}$ in. wide, at a feed of $1\frac{1}{8}$ in. per minute, the cutting feed being 75·5 ft. per minute. After milling eighteen of these bars—a total length of 130·5 lineal feet, and cutting continuously for twenty-three hours and removing 380 lb. each, the cutters were quite uninjured; also, the screw-threads on the armour-plate bolts previously referred to are milled at a cutting speed of 330 ft. per minute, with a feed of 15 in. per minute.

HEATING, HARDENING, AND TEMPERING THE CUTTERS.

With regard to the most suitable processes for the heating, hardening, and tempering of cutters, it is advisable to first fill up the hole and machined parts which it is required to keep to size for fitting on the arbour and keys, with common fireclay. Then place the cutters into a cold muffle furnace; heat up the furnace gradually to a red heat; then transfer

A—45 MINUTES' CUTTING WITH AN "A.W." TOOL.

Cutting speed, 150 ft. per minute. Depth of cut, $\frac{3}{16}$ in., with a feed of 16 cuts per inch of traverse.

B—RADIAL ARM DRILLING MACHINE,

With feed as used for High-Speed Twist Drills when drilling cast iron at 25 in. per minute with $\frac{3}{4}$ in. diameter drills.

the cutters to another furnace already heated to a very bright yellow, about 2,200° F., and allow the cutter to remain in until the teeth or cutting edges are heated to the same temperature as the furnace. Place the cutters under the air-blast until the temperature is lowered just below visible red, that is 1,000° F. Remove cutter from the blast and place into a pan containing tallow, and then heat up the pan to a temperature ranging from 500° to 600° F. Take out and allow to cool gradually, keeping away from cold draughts.

HIGH-SPEED STEEL FOR TWIST DRILLS.

A development of high-speed work, which was not at first looked for, has been in the manufacture and use of twist drills. Many attempts have been made to produce twist drills from ordinary self-hardening steel with usually very indifferent success. Now, however, twist drills made of high-speed steel are a practical success, and are largely in use. To those who are not acquainted with the working of these drills, the results obtained from them will be interesting.

An "A.W." twist drill of 1 in. diameter working on steel plates of 2 in. thickness at 250 revolutions per minute, and 5 in. feed per minute, generally drills 150 holes without re-grinding.

The following is a comparison between a high-speed drill and an ordinary twist drill. Drilling on gun cradles of 5 in. thickness, an ordinary American twist drill did eight holes only and failed, the end being completely burnt up, whilst an "A.W." drill did 124 holes at the same speed and feed without suffering any injury whatever. The drills were 2 in. diameter, running at 80 revolutions per minute, and each hole was drilled in six minutes.

The high-speed drills are equally efficient when used on cast-iron, performing two to three times the work accomplished by ordinary twist drills, as for instance: At the works of Messrs. Alfred Herbert, Ltd., Coventry, an "A.W." twist drill of 1 in. diameter drilled thirty holes through a 3 in. cast-iron block, each hole being drilled at the rate of 7½ in. feed per minute, the drill being uninjured; while a ¾ in. tool drilled cast-iron at 25 in. per minute.

FINISHING QUALITIES OF THE STEEL.

The finishing qualities of high-speed steel have also been a matter of some contention, but there is abundant evidence that it will cut at high speeds and yet give a splendid finish at the same time. In support of this the author may refer to a visit recently paid to the works of the above company (Messrs. Herberts), the finish obtained at high cutting speeds there seen being a revelation. The most excellent finish possible is obtained by them in their very ingeniously designed machinery and when taking one cut only; and their system, and the working of their machinery in conjunction with high-speed steel, is indeed a tribute to the development of thoroughly up-to-date engineering and rapid production of work bearing a high standard of accuracy.

A QUESTION OF NATIONAL IMPORTANCE.

It cannot be denied that the question of high-speed cutting is one of national importance to our country, for if we are to remain successful and retain our position in the engineering world, we must not only possess the best and most modern designs of machine tools, but we must also produce the best qualities of tool steel to serve them to their utmost producing capacities, for it matters not how excellent the one may be if the other is a laggard; the one must be the reciprocal of the other as near as practically possible. Speaking for high-speed steel we must feel that we are only in the early stages of its manufacture and use, and that nothing approaching finality has been arrived at. When the steel maker looks at the innumerable alloys of whose behaviour and proportions when mixed with steel so much has yet to be learned, and also to the infinite number of combinations and percentages of those alloys with steel, and the corresponding varied results obtained, it is easily seen what a large field of research there is yet to traverse.

The Welding of Aluminium.

ALUMINIUM, the most recent of the useful metals, has unquestionably a great future before it. A serious drawback in its application for many purposes, however, has been the difficulty of welding it. As Mr. Sherard Cowper-Coles pointed out in a paper recently contributed to the Faraday Society, soldered aluminium joints have proved unsatisfactory—they will not stand the test of time, as galvanic action takes place between the aluminium and the solder, which of necessity is composed of metals that are electro-negative to aluminium in a voltaic couple. Another difficulty experienced is the complete removal of the film of oxide from the surface of the aluminium to insure the proper adhesion of the solder. The most serious difficulty encountered when welding aluminium is that at a few degrees under its melting point aluminium passes into a mushy or brittle state, and being a very good conductor of heat, the solder rapidly cools, and freezes before flowing sufficiently.

Mr. Cowper-Coles has invented a process for welding aluminium in which no flux or solder is used and which does not necessitate the hammering of the joint when in the semi-fluid state.

The process is especially suitable for wire rods and tubes and other drawn or rolled sections, and consists in placing the parts to be welded after being faced off square, in a machine (fig. 1) fitted with clasping screws, which are capable of moving horizontally on guides; the movement of the clamping screws is controlled by the levers D. The aluminium

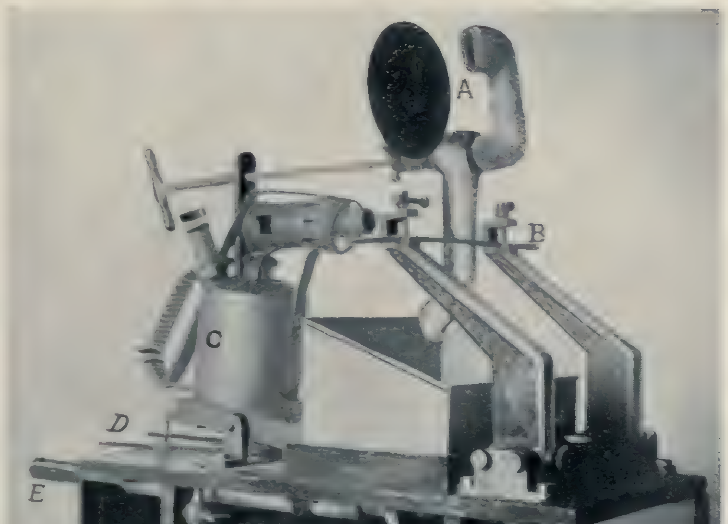


FIG. I. COWPER-COLES MACHINE FOR WELDING ALUMINIUM.

A, Screen; B, Aluminium Rods; C, Lamp; D, Levers for applying pressure; E, Pump; F, Water Reservoir.

FIG. 2.

to be welded is heated by means of an ordinary benzine lamp. As soon as the rods have arrived at the necessary temperature, slight pressure is applied to the levers D, which causes the aluminium rods to unite, and a ring of metal is squeezed out. This ring is largely composed of aluminium oxide, and acts as an insulating and supporting collar, the molten metal being retained within this collar. The weld is then instantaneously quenched by turning a handle attached to the screen A, which allows water, under pressure, to be projected on to the joint from the reservoir F. The same handle H, which turns the water on, places a screen A in front of the heating flame, the water pressure is maintained by air supplied by the hand-pump F. The rod is finally removed from the machine and the collar filed off, when it will be found that the joint is as strong as the rest of the metal. An oxy-hydrogen flame or ordinary gas, with or without air, is substituted for the benzine lamp. The process is a simple one and can be worked by any unskilled workman.

Fig. 2 clearly shows the molten aluminium supported by a pipe or case of aluminium oxide, the case having been pricked with a steel point to allow some of the molten metal to flow out.

The following table gives the result of tests for tensile strength on twelve consecutive welds (not picked specimens) made by the process just described. The fractures occurred at a considerable distance from the weld, showing that the metal had not deteriorated at the weld. In the twelve tests referred to, not one specimen broke through the welded portion.

Dimensions.	Area.	Reduction of area at fracture.	Extension		On Original Area.				Remarks.
			on 4 in.	on 2 in. at fracture.	Elastic Limit (Yield Point).		Maximum stress.		
					Pounds.	Tons.	Pounds.	Tons.	
Diam. in.	Square inches.	Per cent.	Per cent.	Per cent.	Per square in.		Per square in.		
0·249	0·0487	7·4	8·0		11491	5·13	20249	9·04	Broke outside datum points.
0·248	0·0483	7·4	13·0		8803	3·93	22265	9·94	Ditto do.
0·254	0·0507	7·5	8·0		11043	4·93	19868	8·87	Ditto do.
0·252	0·0499	7·4	11·7		14358	6·41	16150	7·21	Ditto do.
0·252	0·0499	7·7	13·0		21996	9·82	21996	9·82	Ditto do.
0·250	0·0491	7·6	9·0		14134	6·31	19622	8·76	Ditto do.
0·250	0·0491	7·7	9·0		14134	6·31	14134	6·31	Ditto do.
0·254	0·0507	7·9	11·0		15030	6·71	24304	10·85	Ditto do.
0·251	0·0495	7·8	7·8		14940	6·67	20361	9·09	Ditto do.
0·253	0·0503	7·7	14·0		10236	4·57	19152	8·55	Ditto do.
0·250	0·0491	7·7	9·0		12320	5·50	20070	8·96	Ditto do.
0·247	0·0479	7·7	9·0		8422	3·76	18704	8·35	Ditto do

THE BRITANNIA OIL ENGINE.

As a simple type of oil engine designed to run equally well in light medium or heavy loads, the Britannia automatic engine, shown in fig. 1, is already well known. It is, however, such a useful type that a short description can scarcely fail to be of service to many of our readers—more especially those who are in search of an all-round engine which can be worked by any one of ordinary intelligence after a lesson or two.

The most characteristic feature of this engine is that after the simple operation of starting, no lamp or external flame is required, the heat of the explosion serving to gasify the oil and also to maintain the gniter at a red heat. It will thus run for many hours without attention. The igniter is so arranged as not to be subject to the pressure of the explosion and there is no air or oil under pressure anywhere in the engine.

The designer has avoided any kind of reservoir of oil fixed over the engine as being both dangerous and unsightly. Instead of this the petroleum is drawn direct from a tank in the engine bed by a novel oil feed, which obviates the use of mechanically-driven pumps.

THE OIL FEED.

For the following particulars and the accompanying diagrams we are indebted to "Engineering." The combustion chamber in the Britannia engine is prolonged by the casting A, shown in fig. 2. On its upper side this casting carries a ribbed chamber, which communicates with the interior of the cylinder through a special vapour-valve B, best seen in fig. 3. When the engine is running at full load, this vapour-valve is opened at every second out-stroke of the piston by a cam mounted on the side shaft. The piston moving forward leaves a partial vacuum behind it, which vacuum is communicated to the vaporiser through the open vapour-valve. Air to fill this vacuum enters through the main air-valve and also through an air-pipe communicating with the vaporiser, so that the air charge of the engines enters in part through the vaporiser and vapour-valve, and in part through the main air-valve. A throttle on the inlet to the latter enables the proportions of air entering in the alternative ways to be adjusted as required. At the same time that air enters the vaporiser, oil is also drawn in from the tank in the engine framing, which, it will be seen, is connected to an oil-suction device by the oil-pipe D.

This device is shown on a large scale in fig. 4. Here the oil supply enters at the tube E, the open end of which is closed by the sleeve F, the top of which forms a valve, as indicated. A few holes are, however, pierced through the sleeve, so that when it moves out, owing to the suction of the vacuum on the piston end of the sleeve, oil can be drawn through these holes into the vaporiser. The amount which thus enters is adjusted by means of a throttle on the main air-inlet, since if this is partially closed, the vacuum in the cylinder on the suction stroke is increased, and hence the oil is sucked up into the vaporiser in greater quantity. Unless the vapour-valve is opened by its cam, there is no vacuum produced in the vaporiser on the out-stroke of the piston. This vapour-valve forms the only means of communication between the vaporiser and the interior of the cylinder, and this fact is relied on to govern the engine. The governor which is of the ordinary centrifugal type, raises or lowers the striking-piece of a hit-and-miss arrangement of the usual kind, the vapour-valve being opened by its cam, or remaining closed, according to the position of the governor balls. From the vapour-valve two passages communicate with the cylinder.

THE IGNITING PLUG.

In the smaller of these passages is placed the igniting-plug G. This is simply a piece of steel drilled as shown, so as to leave projecting ribs. These ribs absorb heat during an explosion, so that whilst the

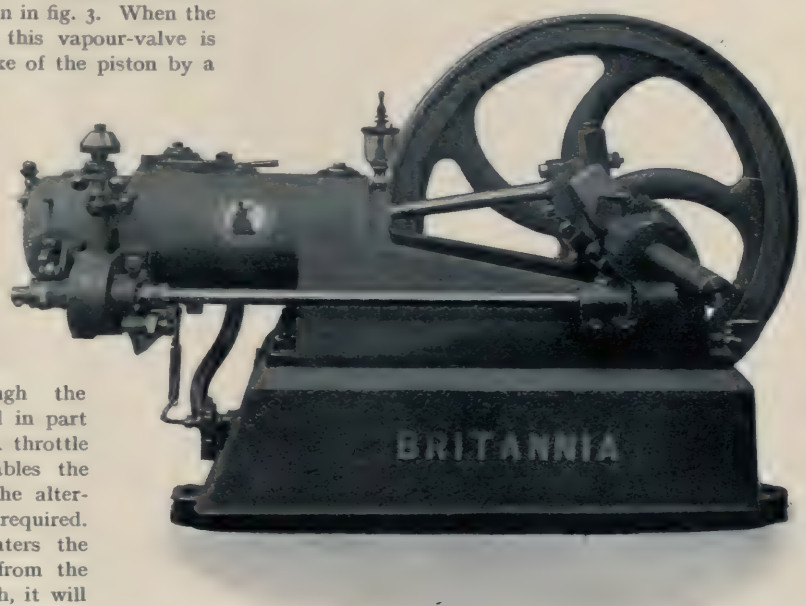


FIG. 1. THE BRITANNIA AUTOMATIC OIL ENGINE.

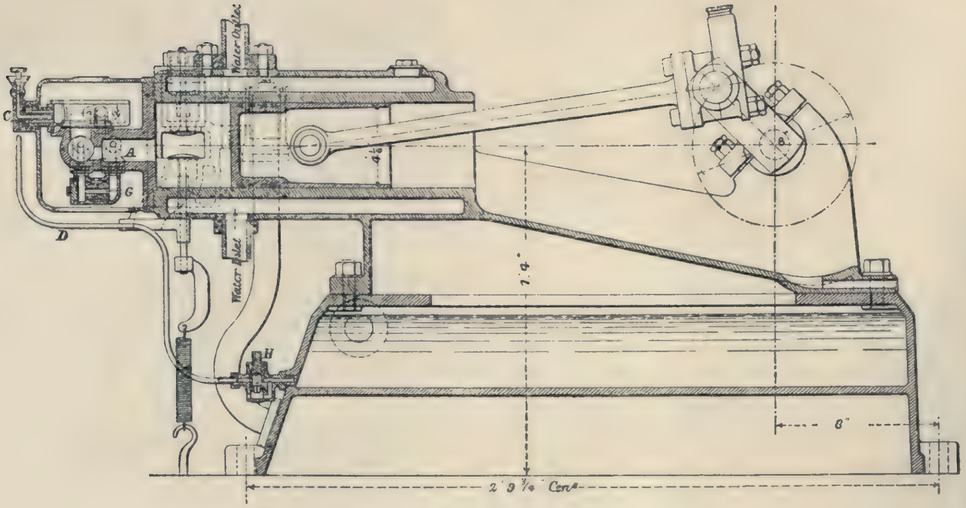


FIG. 2. THE BRITANNIA ENGINE—SECTION.

main mass of the casting A and the vaporiser attain a black heat only, the piece G becomes red-hot. It fails, however, to ignite the mixed gases which pass through it on the out-stroke of the engine, because this mixture is too rich to fire. On the compression stroke, however, the gases forced back through the plug become richer and richer in oxygen until ignition finally takes place. On exhaust none of the waste gases are discharged through the igniter, or superheater. On light loads no gases pass through the igniter or into the vaporiser, unless there is to be an explosion on the succeeding out-stroke. Both plug and vaporiser therefore maintain their temperature, and the engine is not brought to a stop through unintentional missed ignitions.

The funnel shown above the oil-inlet is used in starting the engine. It provides a means by which the oil-pipe D can be filled. This oil is prevented from passing into the tank in the engine-bed by the non-return valve H.

The following parts which exist in other oil engines have been completely done away with: Constant burning lamp, ignition tube, timing valve, overhead gravity feed, oil pump, air pump, oil measure and air blast for starting. The advantages of an engine not requiring a constant burning lamp cannot be overestimated. There are uses to which it can be put where it would be absolutely impossible to use an engine with a lamp. The Britannia engine is made in various sizes by the Britannia Engineering Company, Ltd., of Colchester.

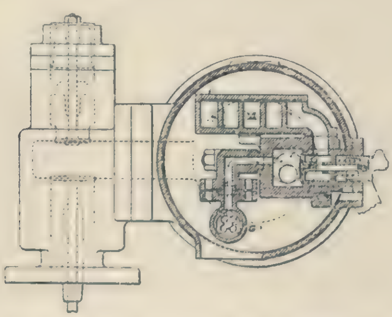


FIG. 3. SHOWING DETAILS OF VAPOUR VALVE.

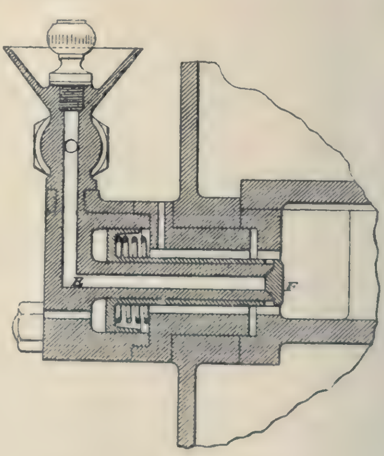


FIG. 4. DETAILS OF OIL FEED.

Radium and its Relation to Matter and Electricity.

By A. F. P.

A Summary of Recent Articles on (1) The Constitution of Matter; (2) Radium; (3) The Rontgen Rays; (4) The Electric Waves used in Wireless Telegraphy.

(1) THE CONSTITUTION of MATTER.

WE shall find it most convenient to begin with a description of the ideas which were held on this subject twenty years ago. In those days, the smallest particle of matter which was supposed to exist at all was called the Atom. Take any substance (a piece of carbon, for instance) and keep on dividing it into smaller and smaller particles. It was imagined that by continuing to divide it one finally came to something which was indivisible—this was called the atom. We get some idea of the size of the atom from the fact that even in a very light substance such as air, one cubic inch contains 100 trillion, (*i.e.*, 100,000,000,000,000,000,000) of these atoms. The atoms in air have plenty of room in which to move about, and dash about freely (in pairs) in every direction with an average velocity of about a third of a mile per second; when they come to any solid substance, such as the wall of a room, their bombardment against it produces a pressure on it of fifteen pounds to the square inch—this we call the pressure of the air.

Now in a solid, such as the wood of a table. the clusters of atoms are closer together, so that there are more of them in a cubic inch. They are so much closer together that they have only a limited range of motion, and more or less stay in the same position. The table, therefore, differs from air in possessing a definite shape.

Nevertheless, the important point is that the little clusters of atoms that make up the substance of the table are separated from one another by quite large spaces, comparatively speaking, so that a table is not really a continuous mass, but more like a sponge.

THE AETHER.

What fills the spaces in this sponge-like mass? We imagine a very thin jelly-like substance, which we call *aether*, to fill these spaces. This aether extends out continuously through space to the farthest star, and by means of it waves of light and heat, and possibly other forms of energy of which we know nothing, travel to us from the sun.

There are then two things in the world: (1) atoms of matter and (2) aether, filling up the spaces between these atoms, and, as we say, soaking through these spaces in matters as water soaks through a sponge.

Ever since the beginning of the last century attempts have been made to reduce all forms of matter to one simple basis; we need only concern ourselves with the latest theory of this kind, developed from the phenomena which take place when an electric discharge is made to pass through rarified gases. The work on this subject begun twenty-five years ago led to the discovery of the Röntgen rays in 1895 and, indirectly, of radium in 1898, and has caused us to rearrange our ideas about matter.

MODERN IDEA OF THE ATOM—THE ELECTRON THEORY.

We must not imagine that the older ideas have disappeared; the grounds on which they were built were too sound for that; the best way to put it is that they have been supplemented and extended. Our idea of the atom has changed; it no longer seems to be the smallest particle of matter that exists, for we have good reason to believe that every atom is made up of a great number of small electrified particles, or electrons, as they are called.

THE ELECTRON.

We shall use the word electron repeatedly, so it is well to remember its meaning. It is not the same as the old atom; a large number of electrons in a cluster form an atom. The name electron is given it because it is a small particle which always carries a charge of electricity.

Though there are over seventy different kinds of atoms that we know of, there is only *one kind of electron in existence*, i.e., *the basis of all matter is the same*. The difference between an atom of gold and an atom of silver is simply that the former atom contains more electrons than the latter. Let us be quite clear: A cluster of a certain number of electrons (some thousands) constitutes the atom of silver; about twice the number of the same kind of electrons in a cluster constitutes the atom of gold.

ITS SIZE.

Now, what is the size of these electrons? We remember how very small the atom was supposed to be; imagine this atom to be 160 ft. long, 80 ft. broad, and 40 ft. high (about the size of the ordinary church), then the electrons would be about one-tenth the size of an ordinary pin-head, *i.e.*, about the size of the full-stop in a newspaper. Imagine a few thousands of these full-stops to be thrown into the church; these would correspond to the electrons in the atom. Now, in spite of their small size, these full-stops will fill the church. They will not fill it in the same sense that excursionists fill a railway carriage, but in the sense in which a few soldiers occupy a country, *i.e.*, by rushing about in every direction, they prevent anything else coming in. The few thousand electrons rush about with such tremendous velocity (about 100,000 miles per second) as to prevent anything else coming into the atom, *i.e.*, the space they occupy is hard and impenetrable. This can be illustrated in the following way: Supposing we take a stick and whirl it round and round with tremendous velocity; the stick, however thin, will effectively occupy the whole of the space in which it is revolving, *i.e.*, nothing else is able to get into that space; so that although there is only a thin stick moving round, that space looks and behaves exactly like a hard, solid, circle of wood. Similarly, in spite of the very small size of the electrons, this cluster of madly-whirling energetic electrons behaves like a comparatively large, solid, impenetrable atom.

But what is the electron? For, by breaking up the atom into these, we have only pushed our enquiry into what matter really is one stage further back, we have not got to the end of it. We only know this about it, that it carries a charge of electricity; it may be that the electron is only a charge of electricity in motion, or it may be only aether in motion. This, however, is more or less speculation.

SUMMARY.

In the light of this theory, let us again consider our apparently solid table; the smallest particles of this, the atoms, are simply clusters of madly-whirling electrified particles, the electrons. The size, the weight, the velocity, and the number of electrons in the atom are being and partially have been determined. The size of the electrons we have just illustrated. The speed is from 60,000 to 100,000 miles per second, beside which a rifle bullet is stationary. The number of electrons in the cluster which makes up a heavy atom (such as the atom of gold) is to be reckoned by hundreds of thousands. A swarm of bees flying together in a cluster will give us a good conception of the atom. There are several kinds of these atoms in the table —Carbon atoms, Hydrogen atoms, Oxygen atoms— differing only in the number of electrons they contain These three kinds of atoms, when joined together in the proportion of six Carbon atoms to ten Hydrogen atoms to five Oxygen atoms, form a larger compound aggregation, which we call a molecule (*i.e.*, little mass) of wood. These molecules are in motion (somewhat restricted in the case of the table) on their own account.

So the small electron moves about inside the atom; the atom moves about inside the molecule; the molecules, which are separated by fairly large spaces, move about inside the table. And through the spaces between the molecules in the table, between the atoms inside the molecule, between the electrons inside the atom, there soaks the aether, as water soaks through a sponge.

So we have not changed our views; there are still, at the most, only two things; previously we thought of aether and about seventy different kinds of atoms, now we think of aether and one kind of electron.

(2) RADIUM.

Radium is an element whose discovery a short time ago by two French chemists (Madame Curie and her husband) was made possible by the patient work of others during the previous quarter of a century.

Radium is very rare; it costs about £40,000 an ounce. This, however, is only an incidental property, and scarcely worth mentioning from the scientific point of view. (The element Radium has never been obtained alone; what is called Radium popularly is really a salt of Radium, such as Radium Chloride —*i.e.*, Radium combined with Chlorine. This does not matter, as the salt exhibits the peculiar properties we are going to speak of just as well as the pure element Radium would. We shall, therefore, continue to talk of Radium, though its salt is being used.)

The properties of Radium are very extraordinary:—

(1) It is continually giving out heat, without receiving it from any external source, and without falling in temperature.

Also, if a small fragment sealed up in a glass tube is carried for a few hours in a waistcoat-pocket, the skin nearest to the Radium is afterwards found to be blistered.

(2) When Radium is left for some time in a closed space, it is found that another substance, a gas called Helium, is being slowly formed. This last property is of great interest, as it is the first known case of one element changing into another.

(3) Radium has some peculiar electrical properties: it will discharge a gold-leaf electroscope, or any other electrified body (a very delicate test which was used in order to isolate it by Madame Curie); it also emits rays which are either Röntgen Rays or rays very similar to them.

In scientific language Radium is said to discharge three kinds of rays:—

α Rays.—Atoms of matter—possibly of Helium.

β Rays.—Electrons.

γ Rays.—Röntgen Rays—or rays similar to X Rays.

The connection between these three kinds of rays and the above properties will be explained as we proceed.

β RAYS

Let us recall our idea of the atom, a cluster of electrons revolving round one another with a velocity of about

60,000 to 100,000 miles per second. Naturally, with this terrific velocity, it is impossible for all the electrons to remain in the cluster, and some of them fly off into space, *i.e.*, the atom slowly breaks up. Since our attention has been called to this fact, we have discovered that all atoms are breaking up; the point about Radium is that its atoms discharge electrons (*i.e.*, break up), many million times faster than any other element we know.

These electrons carry a negative charge of electricity, and constitute what are called the β Rays; owing to their small size compared with the atom they will pass easily through glass and light solids; they will penetrate a foot of wood or aluminium, and even three-eighths of an inch of a heavy body, such as lead. When Radium is brought near an electrified body these electrons hitting against the body carry away, and in other ways cause a discharge of, its electrification.

α RAYS.

Now the loss of one or two electrons, small though it is, has a very serious effect on the rest of the atom. Suppose that, in a nicely-balanced fly-wheel, revolving at a very great speed, a small portion were to come loose and be hurled away; the balance and cohesion of the rest of the fly-wheel would be seriously disturbed, and it is quite possible that the whole fly-wheel itself would shortly afterwards break up and fly into pieces. This is exactly what happens to the atom; the loss of an electron upsets its nicely-adjusted balance and it proceeds to break up. In the case of Radium the atom breaks up into two unequal parts, a large cluster and a small cluster; the large cluster is unstable, the small cluster is stable and is probably an atom of Helium. These atoms of Helium are (so to speak) slung away with a velocity of about 20,000 miles per second and form what are called the α rays.

(Helium is a very light gas, whose atoms are about four times as heavy as the lightest atom known, that of Hydrogen. The atom of Radium is very heavy, being about 225 times the weight of the atom of Hydrogen, which, in its turn, is about a thousand times as heavy as an electron.)

The larger unstable cluster "emanates" slowly from the Radium (it is called the "Emanation") and appears to go on splitting up again and again, each time discharging more atoms of Helium. In the end stable atoms are formed; it is unlikely that they are all of one kind, but what has been formed besides Helium we do not as yet know. Towards the end, too, there is an increased emission of electrons or β rays.

The α Rays, then, are atoms of matter, very much larger than the electrons; they carry a positive charge of electricity. Owing to their large size they are stopped by glass, wood, a sheet of paper, or even a layer of air an inch or two thick.

The α Rays are by far the most important of the three kinds—they contain more than 99 per cent. of the total energy given off.

PRODUCTION OF HEAT.

Radium, as we saw, is continually breaking up, discharging both electrons and atoms with tremendous velocity. Supposing any of these particles hit a thermometer or the skin? What happens? What happens when a bullet hits a target? So much heat is produced that the lead is melted and spattered about and the target is damaged. So when these particles hit anything which stops their motion, heat is produced, the thermometer rises, the skin is blistered.

The chief way in which Radium obtains heat, however, is through being bombarded by its own rays; the atoms in the interior of the mass discharge α and β Rays; these hit against portions of Radium near the exterior, and are stopped dead; the heat evolved keeps the temperature of the whole mass about $1 \cdot 5^{\circ}$ centigrade above its surroundings.

(The latest idea is that the sun contains Radium, and that the breaking up of the Radium atoms supplies the sun with fresh heat and keeps up its temperature. There is a certain air of probability about this theory; for Radium, when it breaks up, forms Helium, and we know Helium exists in the sun; in fact it was known only as existing in the sun (whence its name) for many years before its discovery on the earth by Ramsay in 1895.)

FORMATION OF HELIUM.

This property is now quite clear—there has been a direct change of one element into another.

Helium is always tested for by the spectroscope. This is, fortunately, an exceedingly delicate test, as a very small volume of the gas is formed from the minute quantities of Radium available for experiments. (The total amount of Radium available in the world at present is about a teaspoonful.)

The Radium is put into a glass tube from which all the air is removed; any gas which comes off is condensed at the lowest temperature known (that of liquid Hydrogen); after a few months the presence of Helium in the condensed gas can be detected by the spectroscope.

Helium is formed by the breaking up of Radium; it is possible that Radium itself is only an intermediate product formed by the breaking up of heavier atoms. We said, a little while back, that all elements seem to be breaking up. If this is so, everything is undergoing the same change as Radium, although more slowly, and is forming more simple elements. In the same way, every element has probably been formed by the breaking up of more complicated elements.

It is possible now to understand a little better the connection between two elements such as gold and silver. The principle of evolution seems to have been in operation, gold and silver being probably both produced by the breaking up of some common ancestral element. There is the same relationship between them in a way as between man and an anthropoid ape, which seem physically both to be derived from some common ancestor. Here, however, there has been an ascent from a more simple type, whereas gold and silver would be a descent from a more complicated

type. Looked at in this way the change of gold into silver is no more possible than that of a monkey into man.

Twenty years ago it was nearly a doctrine of faith that the atom, and therefore the element, was unchangeable. It shows the difference that Radium has made in our ideas when we now have reason to believe that the whole world is very slowly changing into a simple form of matter. Who shall say where this change may stop, short of the aether of space?

(3) RÖNTGEN RAYS.

The last property brings us to a consideration of the Röntgen or X Rays, for the γ Rays emitted by Radium are either X Rays or rays similar to them.

The X Rays were discovered by Professor Röntgen in 1895. He used, in order to produce them, a Crookes tube—*i.e.*, a highly-exhausted vacuum tube through which an electric discharge is taking place. The rays given off from this tube, though producing very little effect on the eye, make a phosphorescent screen luminous, and will act on a photographic plate. They will pass, to a greater or less extent, through articles of wood, clothes, flesh, or metals. Any of these bodies placed between the Crookes tube and the screen, casts a more or less dense shadow on the screen. It is found that the rays pass more easily through light than through dense solids; consequently, in the case of the hand, the bones form a darker shadow on the phosphorescent screen than the flesh, and we get the skeleton-like effect with which most people are by now familiar.

It is found that in a Crookes tube small electrified particles—our electrons, in fact—are being discharged in their usual vigorous manner across the tube from the negative pole. The negative pole is generally made so as to focus the electrons on one particular spot, where a piece of some heavy metal (such as Platinum) is placed in order to stop them dead. This sudden stoppage produces, in addition to heat, the waves in the aether which he called the X (*i.e.*, unknown) Rays.

To return to the illustration of the target. A bullet hitting a target gives out a flash of light—*i.e.*, sends out waves of light through the aether. So these electrons, which are very much like bullets, when suddenly stopped dead, cause waves (not of light, but waves similar to those of light) to pass through the aether. These waves, or X Rays, then, are produced whenever electrons hit against any substance, and their motion is checked.

It is easy now to see why Radium emits rays similar to the X Rays. The particles flying off from atoms in the interior of the substance, hit against atoms on the exterior; their motion is checked, and the γ Rays are produced.

Another explanation is that the γ Rays are produced, not by the stopping of the particles, but at the moment of their sudden discharge when the atom breaks up. In this case the emission of γ Rays must be compared with the light given out by the explosive action in a gun.

The γ Rays have very great penetrating power—even more so than the β rays.

(4) HERTZ WAVES.

Leaving Radium, we might try to answer the question: In what way do the X Rays differ from—

(1) Light Rays.

(2) The Electric Waves used in Wireless Telegraphy (called *Hertz* Waves, after their discoverer) which will pass through solid walls?

We spoke of a thin, jelly-like substance, called the aether, which soaks through all matter as water does through a sponge, and said that this solid table was not really a continuous mass of matter, but consisted of very small particles, with very large spaces in between, these spaces being filled by the aether.

Now, X Rays, Light Waves, Hertz Waves, are all the same in one sense—they are all waves in the aether. They differ from one another only in the same way that the sound wave (an air wave) produced by striking a note at the top of a piano differs from the sound wave from a wire at the bottom of the piano. Imagine our ears to have a much less range than they have, so that we only hear notes in the middle of the piano—*i.e.*, notes within the range of the human voice. We should not hear a note struck at the top of the piano, because it would be too high; we should not hear one at the bottom, because it would be too low.

Now, our eyes have really a rather limited range as far as aether waves are concerned. We cannot see the X Rays; their note—if we can so call it—is too high for our eyes. We cannot see the electric waves used in wireless telegraphy; their note is too low for our eyes. There is no more difference, in this sense, between X Rays, light rays, and the electric waves used in wireless telegraphy than between the notes struck at the top, middle, and bottom of a piano; the latter are all sound waves in air, the former are all electric waves in aether.

Our eyes will only respond to waves within a rather limited range. These waves we call waves of light. We have consequently to invent an "eye" for X Rays, such as the phosphorescent screen (made of a chemical such as barium platino-cyanide), of which mention has been made. Or we can make the X Rays take a shadow photograph. In this case no camera is needed; the photographic plate (protected from light by being enclosed in an envelope) is placed on the table; above the plate the hand is placed; above the hand the Crookes tube. More rays pass through the flesh than through the denser bones; more through the bones than through a metal ring; so that in the photograph the flesh comes out very faint, the bones blacker, and a metal ring quite black.

To recognise the electric waves in wireless telegraphy, a special piece of apparatus is used, called a Coherer; the construction of this does not matter very much just now, as long as we understand that it serves as an "eye" for these Hertz waves, in the same way as the photographic plate and the phosphorescent screen are "eyes" for Röntgen Rays and our own eyes indicate the presence of waves of light.

WHY WAVES OF LIGHT DO NOT PASS THROUGH SOLIDS.

But why do X Rays and the Hertz waves pass through solids, whilst waves of light do not? Light waves will not pass through because the waves are about the same length as the spaces between the atoms in a solid. X Rays will go through because they are so much smaller than these spaces. Hertz waves will go through because they are so much larger than these spaces.

The space between the atoms is, roughly stating, about the hundred-millionth part of an inch; a light wave is about the same distance across, and is many thousand times greater than the distance across an X-Ray wave. Hertz waves may have any size from a few inches to many miles across.

Imagine these waves to be the ordinary waves of the sea; imagine the solid to be a long row of high stakes at regular intervals apart in this sea, broadside to the waves.

Suppose that the stakes (which represent atoms) are about three feet apart, and there are forty or fifty rows of them for the waves to get through.

(*a*) Waves of from two to ten feet across will be broken up and almost entirely stopped, and inside the stakes there will be calm. This corresponds to waves of light breaking on a piece of wood—behind the wood it is dark.

(*b*) Imagine the great breakers of the ocean 80 to 100 feet across to break on the stakes; these waves will pass through almost as if the stakes were not there. Similarly, a wall a foot or two through will have very little effect on the Hertz wave two or three miles across, in fact, less than the thinnest tissue paper will have on the light of the sun.

(*c*) Imagine the spaces between the stakes to be some thousands of feet instead of three feet, our waves of two to ten feet will pass through without any trouble. This corresponds to X Rays passing through the spaces between the atoms. If the barrier of stakes be made more dense, the waves will pass less easily through it; in the same way X Rays pass with more difficulty through heavy dense metals than through light wood.

So solid matter is transparent to the Hertz waves because they are so big; to Röntgen Rays because they are so small.

THE LIGHT OF THE FUTURE.

Waves of light are after all only a particular kind of electric wave which happens to be able to excite the nerves at the back of the eye. Our methods of producing these particular waves at the present day are very crude; we create a tremendous jumble of waves of every size, on the off-chance of there being a few of the kind we want. Now if we want a note such as C natural on the piano, we can press a key and get a fairly pure sound (not quite so, because the octaves are always there); we don't sit on the keyboard or hit it with a sandbag somewhere about that particular spot; in the same way we shall probably be able to invent some electrical device which will serve as an efficient light "piano"; by pressing a key we shall get a nearly pure "note" of light. We shall then have obtained a light like that of the glowworm, without heat, and without undue waste of energy. As Professor Oliver Lodge says: "It is not too much to say that a boy turning a handle could, if his energy were properly directed, produce quite as much real light as would be necessary for use in a small town."

REMAINING PROPERTIES of RADIUM.

One or two facts about Radium still remain to be noted.

(1) Radium is faintly luminous. This appears to be a property not of Radium itself but of its "emanation" (*q.v.*). This property can be transferred to other objects: The hands and clothes of a person handling Radium glow with a phosphorescent light, which lasts for some time after the Radium has been put away.

(2) If Radium, or bodies like it, are placed near a phosphorescent screen, the rays falling on the screen make it glow and give out light. It is just possible that by making use of this property we may obtain an economical source of light in the future.

(3) If a very small particle of Radium be placed in front of a screen containing zinc sulphide, the α Rays (atoms of Helium) produce a very curious effect. As each atom hits the screen, the same effect is produced as when a bullet hits a target, *i.e.*, a flash of light is produced. This bombardment of the atoms can be seen in a darkened room by means of an instrument called a Spinthariscope.

(4) The ore of Radium is called Pitchblende. About 12,000 tons of this would have to be treated to obtain one pound of Radium; consequently, the process of separation is very long and tedious.

(5) Radium is said to be a cure for cancer. This at present seems doubtful.

(6) It is probable that the medicinal properties of certain waters, such as those at Bath, are due to small quantities of Radium existing in them.

SUMMARY.

Radium.

α Rays.	Atoms of Helium—velocity about 20,000 miles per second, easily absorbable, and stopped by even a sheet of paper. Recognised in Spinthariscope. Carry positive charge of electricity. The most important of the three kinds of Rays. Contain 99 per cent. of energy given off.
β Rays.	Electrons (mass $\frac{1}{800}$ of atom of Hydrogen) velocity about 100,000 miles per second. Will penetrate a foot of wood. Carry negative charge of electricity.
γ Rays.	Probably Röntgen Rays—waves in the ether. Great penetrating power.
The "Emanation."	Luminous. Something like a very heavy gas. "Emanates" from Radium as an intermediate product in the formation of Helium.

Radium is always about 1·5 deg. C. above the temperature of its surroundings—it has marked physiological effects—its rays will discharge electrified bodies and act on a photographic plate.

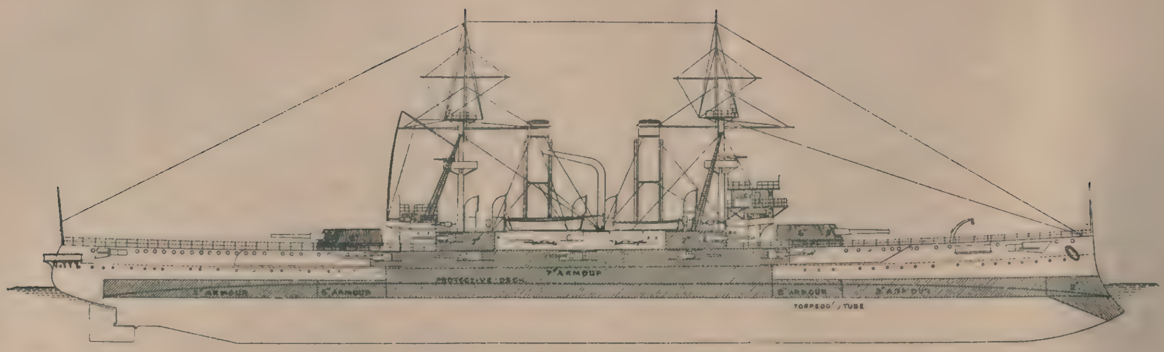
All of these properties are due to the breaking up of the Radium atom; a specimen of Radium is continually losing weight, but its life is probably over a thousand years.

APPENDIX.

Scale of Electric Waves in the Aether.

Number of Vibrations per Second:—

Probably Trillions ..	..	X-Rays.
2,000 Billions ..	..	Actinic Waves (waves used in Photography).
750 Billions to about 400 Billions.	Violet Indigo Blue Green Yellow Orange Red.	The Range of Human Sight. (One octave.)
100 Billions.. ..	..	Below Red—chiefly Waves of Heat.
230 Millions downwards ..		Electric Waves used in Wireless Telegraphy, *i.e.*, Hertz Waves.



PROFILE OF H.M.S. "TRIUMPH" (LATE LIBERTAD).

NAVAL ARCHITECTS' SPRING MEETING.

AN ACCOUNT OF THE ANNUAL MEETING OF THE INSTITUTION OF NAVAL ARCHITECTS.

THE annual meeting of the Institution of Naval Architects was held in the hall of the Society of Arts (by permission of the Council) on Wednesday, Thursday and Friday, the 23rd, 24th, and 25th of March, and was well attended. The Right Hon. the Earl of Glasgow, G.C.M.G., LL.D., presided.

WEDNESDAY.

Proceedings commenced with the presentation of the annual report of the Council, which was read by the Secretary, Mr. R. W. Dana. The following is an abstract :—

The Council had pleasure in reporting the institution's satisfactory progress during the past year. The increase in the roll of membership* was above the average of recent years, and the list of new candidates for admission was well maintained. The treasurer's report spoke for itself of the satisfactory condition of the institution's finances. The losses by death recorded in the report included the Earl of Ravensworth, second president of the institution, who for thirteen years ruled over its destinies, Sir Frederick Bramwell, K.C.B., F.R.S. (vice-president), and Mr. John Scott, C.B. (vice-president)—an original member of the institution.

It was announced that there will be no regular summer meeting this year, but that an invitation has been received from the Committee of the International Engineering Congress to be held in St. Louis, U.S.A., commencing on October 3rd, inviting members of the institution to take part in the congress.

Amended rules now submitted for the confirmation of members provided more exactly defined qualifications required of candidates for membership and associate membership. A student class will be created enabling young men between the ages of eighteen and twenty-five to join the institution without entrance fee, and at a lower rate of subscription. The Council also recommended that powers be taken in the bye-laws to hold examinations and confer certificates for proficiency in naval architecture and marine engineering. In view of these changes the Council had great pleasure in announcing that Mr. A. F. Yarrow had intimated his readiness to offer a scholarship of £50 a year in Marine Engineering in connection with the institution —(applause)—Mr. Yarrow's offer being conditional upon a second scholarship of the same value from some other quarter, and the Council hoped that another donor might come forward to fulfil this condition.

The question of an experimental tank in connection with the National Physical Laboratory at Bushey had been further considered by the Council, and in order to elicit a definite expression of opinion on the subject from the members generally, Sir William White, K.C.B., LL.D., at the special request of the Council, had kindly consented to read a paper on the subject of experimental tank work at that meeting. (Hear, hear.)

The Council had much pleasure in announcing the award of the annual gold medal and premium for the past year, viz. :—Gold medal, to Mr. W. H. Whiting, for his paper on "The Effect of Modern Accessories on the Size and Cost of Warships." (Applause.) Premium, to Mr. R. Balfour, for his paper on "Marine Installations for the Carriage of Refrigerated Cargoes." (Applause.)

THE AGE LIMIT OF MEMBERS AND ASSOCIATES.

The report and accounts having been adopted and other formal business transacted, the alterations to rules relating to the admission of candidates were formally dealt with. It was mentioned that the limit of age of members would be raised to thirty, and that of associate members from twenty-two to twenty-five.

PRESIDENT'S ADDRESS.

The President proceeded to deliver his address. After a feeling reference to the losses by death mentioned in the report, he briefly reviewed the present position of shipping, which, it was remarked, had not shown much signs of improvement ; in fact, during the year under review, statistics point to a period of acute depression. The gross tonnage launched during the year in the United Kingdom (exclusive of warships) was 1,190,618 tons, as compared with 1,427,588 tons for 1902, a reduction of no less than 236,940 tons, or over 16 per cent. On the other hand, the tonnage

* Membership (1903) :—Honorary members, 14 ; members, 1,036 ; associate members, 66 ; associates, 511. Total, 1,627.

of warships launched totalled 151,890 tons, as compared with 94,140 tons in the previous year, or an increase of 57,700 tons; so that the total reduction for the year was reduced to 179,190, or under 12 per cent. Moreover, the increase in warship tonnage is due entirely to vessels built in private yards, the total of which is this year almost equal to that of 1901—a quite exceptional year. In Ireland, however, at Messrs. Harland and Wolff's, the tonnage launched during the year had reached the high total of 110,463 tons, or 31,000 tons above the preceding year; while engines aggregating over 100,000 horse-power have been turned out by the same firm. Foreign shipbuilders seem to have fared slightly better, comparatively speaking, than those of the United Kingdom; for, although the returns of most of the principal shipbuilding countries show a reduction on the figures of the previous year, yet this reduction is proportionately less than that for the United Kingdom during the same period. In the field of naval engineering there is little, if anything, to chronicle in regard to new departures during the past year. No doubt our marine engineers have not been lacking in the initiative that has always distinguished them, but such advances as may have been made have been in the improvement of detail. The world is still watching and waiting for the practical demonstration of the use of the steam turbine in larger vessels of the ordinary sea-going class, and ships that are now under construction or about to be tried. These will, doubtless, afford data which will enable engineers and shipowners to form some idea as to whether this new description of prime mover will effect the revolution in marine propulsion foretold by its advocates.

The remaining topics touched upon by the President included the possible utilisation of gas engines on board ship, the use of liquid fuel, the training of engineers, the Yarrow scholarship, and the Navy Estimates. He referred with satisfaction to the provision in these estimates for the thorough renewal of the machinery and equipment of the Royal Dockyards during the next two years, and remarked that the experimental adoption of the premium system in the dockyards would be watched with great interest. If the system was as successful as its advocates predicted, a very great improvement in the dockyard *personnel* would doubtless ensue. (Hear, hear.)

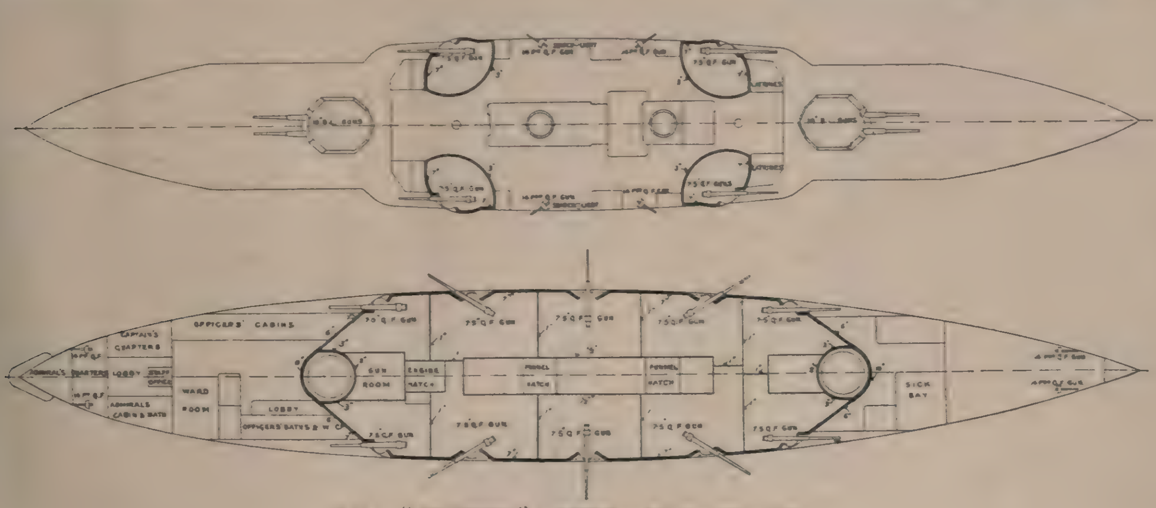
PRESENTATION OF GOLD MEDALS.

The gold medals referred to above were then presented, the President heartily shaking hands with the recipients.

THE "TRIUMPH" AND "SWIFTSURE" AND THEIR CRITICS.

The first paper on the list, by Sir Edward J. Reed, K.C.B., M.P., was largely based upon the criticisms that have been expended upon these vessels, formerly known as the *Libertad* and *Constitucion*, and it may be said to have been dominated by a note of impatience. "It is to be hoped," Sir Edward remarked, "that the future trials and reports upon these ships will be free from the strong adverse bias with which they, since their purchase by the Admiralty, have been treated by the Secretary to the Admiralty and some others."

The paper was largely occupied with a critical comparison between these battleships and H.M.S. *Duncan*, which was recently selected in the House of Commons by the Secretary to the Admiralty for the purpose of comparison. Incidentally, the author said that what the Secretary to the Admiralty could mean by suggesting that, for equal efficiency, the "displacements" must be alike, he did not know; for, if ships with a given amount of fighting power and of speed were to be pronounced inferior because they were of less "displacement," then improvement in design, in so far as economy and efficiency were concerned, was thereby barred. If a ship was of given gun-power and armour, and of given speed (other things being alike), it was absolutely of no advantage to her, but of grave disadvantage, for her to have more displacement than was necessary, for a very large part of the art in the designing of battleships consisted in obtaining the necessary fighting power and speed on the least displacement. From this it also followed that, if one designer could obtain the given power and speed—coupled, of course, with equally efficient armour protection—on much less displacement than another required for the same purposes, it would be obvious to everyone present that the smaller ship was the better ship. The Secretary to the Admiralty seemed to suppose, or to have been induced to suggest, that it was an advantage for the *Duncan* to have 770 tons more weight of hull than



H.M.S. "TRIUMPH." UPPER AND MAIN DECKS.

the *Swiftsure* and *Triumph*, and 530 tons more armour to protect the enlarged hull.

Sir Edward Reed's arguments led up to the claim that, given their size, speed, armour, and gun-power, these vessels have not so far been matched by any other battleships with which he has become acquainted; and "in this remark he might almost include those astounding battleships now building of the *King Edward VII.* class, which, although of nearly 5,000 tons greater displacement, and less speed, are not very much above the *Triumph* and *Swiftsure* in the muzzle energy of the aggregate broadside. Why a secondary battery of only 6-in. guns has been given to these enormous ships far surpassed his powers of conjecture." (Hear, hear.) *

A MARVELLOUS SIMILARITY AND A DISCLAIMER.

A curious point raised was the marvellous similarity between the design of H.M.S. *Cressy* and that of the *Swiftsure*. Sir Edward Reed, however, placed it on record that the design of the *Swiftsure* and *Triumph* was to all intents and purposes settled in Chili without the smallest reference to the *Cressy* or to any other of His Majesty's ships. He went further. He "hoped it was not disturbing to anyone at the Admiralty Office, or to anyone who had been at the Admiralty, to suggest that Admiralty designs had not been considered by him as examples to be imitated. They have always, in his opinion, for many years past been too large for their armaments and their speeds, and it never occurred to him, when arranging the designs of these two ships, to found them upon any Admiralty design whatever, and for that simple reason.

The truth was that he could only account for the large dimensions of many of His Majesty's ships, when taken in relation to their armament and speed, by presuming that their dimensions were fixed in a somewhat arbitrary manner, and so as to be certain that they should be large enough; whereas it was his opinion that the dimensions and power should grow out of, and be the sequel to, the guns to be fought and the speed to be attained. He should have the full concurrence of at least one Admiralty officer of high position in this respect, because the present Director of Naval Construction, Mr. Philip Watts, stood in his estimation as the modern exponent of the system of design which emphasises the gun-power and speed, and brings down to the lowest practical point the weight and power necessary for the purpose in view."

SIR WILLIAM WHITE SPEAKS AS A TAXPAYER.

Sir William White knows as well as anyone the "slings and arrows" that are brought to bear upon Naval constructors by outrageous critics, and while controverting some of Sir Edward Reed's statements, was no doubt able to sympathise with him in this particular. As Sir William reminded us, he can now speak as an ordinary taxpayer, and as he is specially interested, being the designer of the *Duncan* "and a few other vessels"—to use his own unassuming phrase—he availed himself of the opportunity freely. He first took exception to the basis of comparison, pointing out that these two ships had been designed under most favourable circumstances, for they had not formed units in a great fleet, and had been consequently free from special conditions. In these ships, moreover, they had the latest expression of the advances made in armour, armament and machinery, and when a comparison was made between the *Duncan*, designed in 1898, and these ships, designed five years later, that meant a great deal. If he had started again to design the *Duncan* at the present time, he would be able to do more than was possible at the time.

In the course of a friendly fusilade of facts and figures, it was shown that though the *Duncan* is a larger ship than the *Swiftsure* or the *Triumph*, a good deal has been got out of the extra displacement, the *Duncan* carrying 234 tons more equipment, 600 tons additional weight of machinery, and 580 tons additional weight of armour. As to the weight of the hull, Sir William remarked that if Sir Edward Reed could design a lighter hull equally strong, he would like to see the specification. The distribution of armour and guns was also criticised, in detail, and the tabulated muzzle energies for the new ships were questioned, on the ground that the velocities were only obtainable with nitro-cellulose, which was not approved in the Royal Navy.

He gave figures to show that the *Swiftsure* is practically of the same dimensions as the *Cressy* class, of which Messrs. Vickers built two ships; that by omitting wood and copper sheathing over 500 tons were saved in the *Swiftsure*, while the reduction in speed from 21¾ knots to 19½ knots, and in power of engines from 21,000 in the *Cressy* to about 13,000 in the *Swiftsure*, saved over 600 tons. These savings were applied in the *Swiftsure* to increase in armament and armour, but he did not consider that she could do the *Cressy's* work as a cruiser.

The discussion was continued by Admiral FitzGerald, Mr. E. H. D'Eyncourt, Admiral Sir E. Fremantle, the Hon. T. A. Brassey, and Mr. Seaton. Admiral Fremantle mentioned that he had always favoured the small ship, and if the *Triumph* was really equal to the *Duncan*, then a very great stride had been made. The Hon. T. A. Brassey thought the Admiralty had done a very wise thing in purchasing these vessels. They had good speed and good gun power, and in coal capacity were equal to any ship that was now in course of completion, either for our own or foreign navies. Sir Edward Reed received a hearty welcome after his recent illness, and was cordially thanked for his paper.

WANTED—MORE STEAMSHIP SUBSIDIES.

The Right Hon. Lord Brassey, K.C.B., D.C.L., contributed a paper on Merchant Cruisers and Steamship Subsidies, in which he urged a more liberal expenditure on subsidies to fast ocean services, thus providing the fleet, at the lowest cost, with a reserve of ships for scouting duties. It was argued that our shipbuilding should be concentrated more largely on battleships and their indispensable auxiliaries the destroyers. The armed cruisers for the protection of commerce must be regularly built vessels of war. Ships for scouting should be obtained from the Mercantile Marine. Speed and coal endurance are the essential qualities. No vessels of war have as yet been equal to the ocean liners. The German ships have an ocean speed of 23½ knots.

Foreign countries look on their fleets of postal vessels as indispensable auxiliaries to their navies. They are liberal in subsidies. In proportion to the tonnage of their mercantile navies and the requirements of their fleets, they are more liberal than the British Government. The total annual payments

[* This extract has been revised by Sir Edward Reed since the reading of the paper.]

as reported by the Committee on Steamship Subsidies, are as under :—

British mail subsidies	£756,580
Additional payment to Cunard Company	150,000
Admiralty subsidies	77,813
	£984,393
French subsidies (including bounties for shipbuilding and navigation)	£1,787,271
Russian subsidies	364,756
Austrian subsidies	318,983
Japanese subsidies (approximate)	750,000

In conclusion, Lord Brassey remarked : We have already established mail services to the Cape, to the East, and to Australasia. We may improve those services. The ships may be capable of higher speed. They may be fitted with portable armour, and with bulkheads for more minute internal subdivision when employed as scouts. We may establish new lines, such as those so much desired in Canada, to connect the Dominion with Australia and the United Kingdom. And while fostering trade, providing scouts for the fleet, and increasing the means of training for the engine-room complements of the Navy, and more especially for men on whom we may rely as reservists, we may do something effective in a cause which we all have at heart. Swift communications are a bond of Empire.

The discussion by Professor Biles, and Admirals Morant, FitzGerald and Fremantle was not favourable to the arming of merchant ships, though it was pointed out that these vessels might to a limited extent act as scouts. The work contemplated, however, would be far better entrusted to specially built ships.

THE ANNUAL DINNER.

In the evening Lord Glasgow presided at the annual dinner, which was held at the Hotel Cecil. Following the usual loyal toasts, that of the "Naval and Military Forces of the Empire" was given by Lord Brassey, who seized the opportunity of bearing testimony to the success of our Naval administration under Lord Selborne and his colleagues. Discussing Continental naval Powers, he remarked that in Russia and Germany the main efforts were directed to battleships, in France to cruisers. Battleships we must build and cruisers we must build. What should be the type—the type which would hold the field, even for ten years ? If he argued for some diminution of dimensions, for not putting too many eggs into one basket, he would be taking ideas which might, perhaps, prevail more widely to-day in view of the latest experience of naval warfare. Cruisers for the protection of commerce must be powerful, fast, and of ample coal endurance. Our latest types were noble specimens of naval architecture. The speaker also paid a tribute to the *personnel* of the Navy, remarking that the service had never been wanting in professional skill, in ardent gallantry, and patriotic devotion. The toast was responded to by Vice-Admiral FitzGerald. The remaining toasts included "The Mercantile Marine," proposed by Admiral Sir J. Dalrymple Hay, "Kindred Institutions," by Sir John Thornycroft, "Our Guests," by Dr. Francis Elgar, and the "Health of the President," by Professor J. H. Biles.

THURSDAY.

THE PROPOSED NATIONAL EXPERIMENTAL TANK.

In the course cf a paper on this subject, presented by Sir William White, K.C.B., LL.D., it was shown that the scheme to provide an experimental tank for research work on fluid resistance and ship propulsion at Bushey has been languishing owing to the difficulty of satisfying the requirements of a number of firms who might wish to have models tested at one and the same time. He was in full agreement with the view that it was not wise to contemplate the establishment of a *single* tank in any locality to be available for the testing of ship models in connection with designs.

The inevitable consequence of a fuller recognition of the value of these tanks, as adjuncts to the designing departments of shipyards, must be the establishment by each of the great firms of its own experimental tank.

At the same time he expressed his profound conviction that, if the shipbuilders, marine engineers, and shipowners of this country are well advised, and desire to further to the utmost the maintenance of our supreme position in mercantile ship construction, they will not be slow in providing the funds necessary for the establishment and maintenance, in connection with the National Physical Laboratory, of a tank avowedly devoted to research work on the general principles of fluid resistance, the efficiency of propellers, and other matters greatly influencing economy of propulsion. Generosity in this instance would undoubtedly result in a rich reward. Sir W. White gave an outline of the research work which might advantageously be carried on in an experimental tank such as he recommended. This included investigation of the forms of ships most suitable to fulfil various conditions ; frictional resistance ; the efficiency and design of screw-propellers ; the question of air resistance, which was becoming increasingly important, especially in passenger steamships with enormous superstructures and multiplied shelter decks ; the influence of depth of water on the resistance of ships ; and investigation of the manœuvring power of ships under the action either of their propellers or their rudders. Experimental tanks also furnished the only satisfactory method of dealing at moderate expense with novel proposals for radical changes in the forms of ships, and of dealing satisfactorily with special cases which arose especially in connection with warship design. He did not put forward this list as exhaustive, but to justify the recommendation which he wished to make, that without further delay steps be taken to secure the establishment in connection with the National Physical Laboratory of a tank which should be of service to the whole shipping community and especially devoted to research.

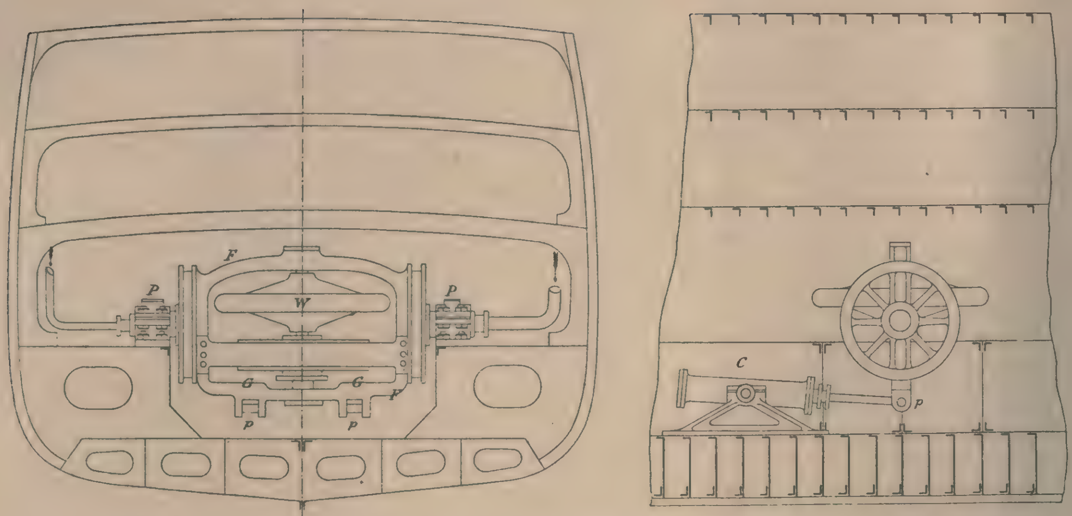
Mr. A. F. Yarrow heartily supported Sir William White's recommendation, and moved that steps be taken to carry it out. This was seconded by Dr. F. Elgar, and carried unanimously. A number of speakers favoured the proposal, including Admiral Melville, U.S.N., Dr. Glazebrook, Herr Carl Busley, Captain Matsuo, Sir Edward Reed and Mr. Philip Watts.

Sir William White thought there would be no trouble in getting the £15,000 required for building the tank, if once the fact were grasped that it would be of real value, while the £1,500 a year estimated to be required for the expenses of working was insignificant in comparison with the saving in cost of coal for the navy and mercantile marine which might be expected as the result of information gained from the experiments.

Sir William White also suggested that shipowners should be appointed on the Committee. This has since been done.

A PRACTICAL ILLUSTRATION SHOWING THE NEED OF AN EXPERIMENTAL TANK.

At the afternoon meeting a valuable paper, entitled "Some Results of Model Experiments," by Mr. R. E.



PROFESSOR SCHLICK'S APPARATUS FOR REDUCING THE ROLLING MOTION OF VESSELS AT SEA.

Froude, occupied the attention of members. The model experiments which form the subject of this paper were resistance experiments, being a series of general experiments on systematic variations in form of hull. They were commenced many years ago, and were continued at intervals as opportunity was afforded by the course of work at the Haslar Experimental Establishment. In the course of discussion Mr. Watts and Sir William White testified to the value of such data to the designer of warships, and Professor Biles remarked that since so many years had been required for the study of practically one form, it illustrated the necessity for such a tank as Sir William White had advocated; otherwise it would be centuries before a complete solution could be at the disposal of ship designers.

A paper on the heeling and rolling of ships of small initial stability, by Professor A. Scribanti, R.Ital.N.R., was taken as read.

THE GYROSCOPE TO CONQUER MAL-DE-MER.

At the evening meeting Professor Otto Schlick described an apparatus which, if successful in application, should earn for him the universal gratitude of sufferers from mal-de-mer. According to Herr Schlick this apparatus makes it possible not only considerably to increase the period of oscillation of a vessel, but at the same time effectively to lessen her angle of heel. This depends in principle on the gyroscopic action of a fly-wheel, which is set up in a particular manner on board a steamer (see illustration) and made to rotate rapidly. It was shown that the energy communicated to the vessel by the action of the waves can be transferred to the fly-wheel, and may, by means of a brake fitted to the latter, be destroyed. The hull of the vessel only transfers to the fly-wheel the energy produced by the waves, and, according to the theory of the top, a very small inclination of the vessel will enable it to do this. In the appliance described, says Herr Schlick, we have an excellent means, if not of *preventing* the motions of a vessel entirely, of at least reducing them to a minimum. In the case of a vessel not fitted with a fly-wheel, it is shown that a wave gives the vessel a certain inclination, which is increased gradually more and more by the following waves. This rapid increase of inclination, after the passing of several waves, is only rendered possible by the circumstance that the damping resistance of the water remains very small (even if bilge keels are fitted) so long as the angle of heel has not become considerable in amount; or, in other words, the work consumed by the damping resistance does not become equal to the energy communicated to the vessel by the succession of waves until a very large angle of heel is reached. The violent rolling motions, then, of a vessel not fitted with a fly-wheel are the accumulated effect of a whole series of waves. When, however, a vessel is fitted with a fly-wheel the conditions become very materially different. In this case the first small inclinations themselves are subject to a powerful damping action, so that an accumulation of roll can never take place. Herein lies the principal work of the apparatus, and at the same time the guarantee for its success. Herr Schlick stated that his principal aim had been to create interest in the scientific aspects of the proposal, while leaving to the future the question of putting it into practice. Some interesting experiments were made in a small tank, and several members joined in discussing the principles of the gyroscope.

OIL AND GAS ENGINES IN VESSELS.

Mr. John E. Thornycroft read a paper on the "Advantages of Gas and Oil Engines for Marine Propulsion," in the course of which he remarked that the advantages which oil and gas engines offered were so great that it was difficult to understand why they had not been more largely used for marine purposes. They necessitated the employment of some complications which steam engines avoided, but the one great advantage of their requiring neither boilers nor condensers would, it was thought, be found to more than compensate for these complications. The different systems, and the way in which they work, were described by the author according to the fuel they employ, under the following headings:—

(1) In which the combustible employed will vaporise at atmospheric temperature.

(2) In which the combustible requires vaporising by heat or by spraying.

(3) Gas engines, using gas from some form of producer using solid fuel.

The first type of engine is necessarily the lightest, as there is no vaporiser or producer, the fuel being vaporised by the simple expedient of sucking the right amount of fuel in with the air to the cylinder. Engines of this class are being made to weigh not more than 10 lb. or 12 lb. per b.h.p. Comparing this figure with that of the modern torpedo-boat's or destroyer's, which is 50 lb. per i.h.p., it is evident that the naval architect has great possibilities with this type of engine. There is every prospect that engines of the second class will be built, including the vaporiser, for not more than 25 lb. per b.h.p. for moderate sizes. The engines of the third-class should not be heavier, but of course there must be added the weight of the producer.

A comparison of the weights and spaces occupied by comparatively low-powered engines of the first class, fitted to launches, in the place of steam engines and boilers of the same power, shows very greatly in their favour; but when petrol is used as fuel, it will be found more expensive than coal to do the same work. On the other hand, as the engines are practically automatic in action, and can be started at once (requiring no preparation like a steam boiler), an engine-driver can usually be dispensed with, and, as the steersman can do all the work of controlling the vessel, it will frequently be found cheaper to run with this class of engine than with steam.

The producer invented by Dr. Mond for using bituminous fuel has not yet been worked out suitably for marine purposes, and as used on land is heavier than boilers of the same power; but it seems probable that, owing to the much greater economy obtained and the rapid development which is going on, it will soon be possible to employ producers of this type.

One of the figures showed the space occupied in a 27-ft. navy cutter by a reversing engine of the second class, replacing the standard pattern steam engine and boiler, which would take just twice the length of the boat. Another showed the relative space occupied by the machinery of a torpedo-boat destroyer fitted with the usual machinery, and an engine of the second class working on the Otto cycle, at the same piston speed as the steam engine.

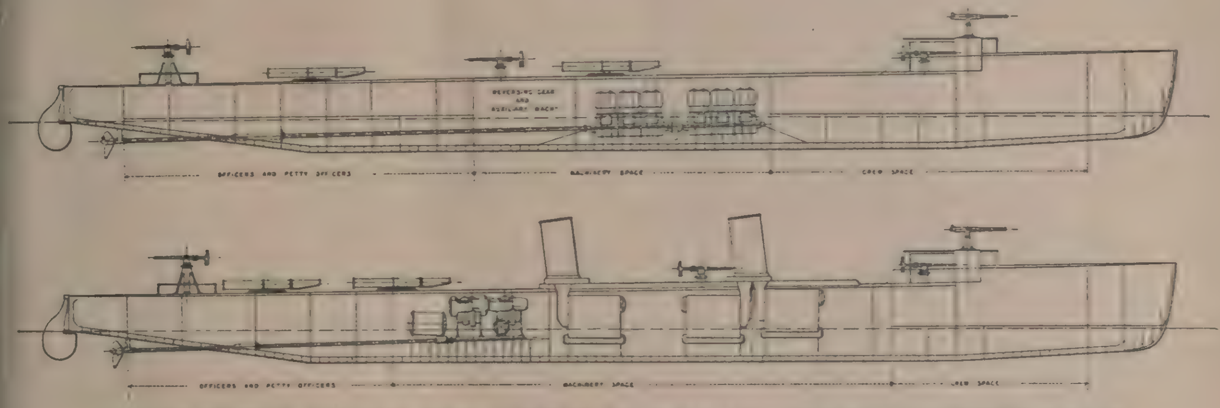
INTERNAL COMBUSTION ENGINES FOR SMALL VESSELS.

Another paper, akin to the last, was read by Mr. Arthur F. Evans, on "The Internal Combustion Engine as a means of Propelling Small Vessels." The author remarked that the application of the internal combustion engine to marine work had placed in the hands of naval architects a power which is destined in the near future to effect a complete revolution in the construction of craft of small tonnage.

The internal combustion engine, or to give it what he considered a more fitting title, "the internally fired hot-air engine," was first applied to marine work by Mr. J. J. R. Hulme, of London, in the year 1885. This was a small inverted cylinder engine, which worked on the Otto cycle and used benzoline —no doubt the ordinary commercial benzoline of about 700° test. It was curious to note, in view of the widespread use of petroleum spirits at the present day, that benzoline was the first fuel to be used in conjunction with marine work. The next oil engine (as he would term it) to be placed on the water was one of Messrs. Priestman's. This was a two-cylinder engine, and was installed in a 28-ft. boat, so that Messrs. Priestman may be regarded as the pioneers of the marine oil engine. The Priestman engine has characteristics which make it very noteworthy, and, considering that their boat was launched in the year 1888, the fact that it was fitted with high tension ignition (in principle precisely as now used) showed how very difficult it was to find anything in the way of mechanical details that was absolutely new.

It was also interesting to note that the first reversing gear tried was a differential gear with a brake, and that this system is not only in general use at the present moment, but that it is, moreover, invented regularly every month by some ingenious and sanguine person. Subsequently, this gear was discarded for the reversing propeller, and he believed that Messrs. Priestman were the first to put a reversing propeller on the market.

A number of other types were described, the author remarking that what is required is an engine that can be started in the morning and shut down at night, and treated in the same manner as the printing office boy treats the shop gas engine. What should be aimed at by designers of marine oil engines for commercial purposes is extreme simplicity, and this question of



DIAGRAMS SHOWING RELATIVE SPACE OCCUPIED BY STEAM AND INTERNAL COMBUSTION ENGINES OF 6,000 I.H.P. FOR A DESTROYER.

simplicity and reliability has, in commercial practice, to stand before fuel efficiency. Perhaps the best instance of this is the Hornsby-Akroyd oil engine.

The paper was illustrated by lantern slides, some very interesting pictures of various motor launches, including one of the earliest and largest motor yachts, a motor fishing boat, a 25-ft. pinnace, the *Mayflower* and the *Alice*. It was remarked that last year (1903) would ever be memorable as being the year that initiated the speed contests in marine automobiling, as it is beginning to be called. It saw the production of an excellent boat by Messrs. Thornycroft, another built by the Saunders Company, and engined with an M.M.C. type motor, and the author's own firm's representative, the *Napier*. In each of these boats a big stride was made both in speed and easy running, as also in price. Up to then £300 was the top price for a motor boat. Twice this amount would not have bought the cheapest of those just mentioned, and the year's racing showed the enormous possibilities there are for boats of this kind. Indeed, everyone who made a journey in one of these boats foretold for their type a great future.

It required no great stretch of the imagination to foresee the possibilities of such machinery for high speed craft designed for even more serious work than motor launch racing. Let the possibilities be considered of a battleship carrying on deck, say, four boats, having a speed of 30 knots, and carrying a 14-in. torpedo tube. They would not weigh five tons each, and should be about 60 ft. long, and might be handled by a crew of four.

This year would show a great advance in the direction of highly developed launches, and he hoped by the end of the season that they would be in possession of data that would be extremely valuable. Of course they had to thank the motor-car builders for these developments, but they must remember that what acted quite satisfactorily in a motor-car might not be all that could be desired in a launch.

With the development in the horse-power available per unit of weight came a parallel development in the lines of the boat, and next year, no doubt, the question of lines for high-speed motor launches would be freely debated.

FRIDAY.

THE RATEAU STEAM TURBINE.

Professor A. Rateau, of Paris, contributed a paper on "Steam Turbine Propulsion for Marine Purposes." There was no need, he said, in a country which had given birth to the Parsons' Turbine, to insist upon the interest attached to the application of the steam turbine to the propulsion of ships.

The three principal difficulties encountered were shown to be :—(1) Design and arrangement of propellers for a high speed of rotation ; (2) efficiency of turbines at low speeds ; (3) reversing and manœuvring powers. These obstacles, in the author's opinion, could only be satisfactorily overcome by a joint use of reciprocating engines and steam turbines.

COMBINED USE OF TURBINES AND RECIPROCATING ENGINES.

The best solution appeared to be the simultaneous employment of a reciprocating engine and turbines attached to independent shafts, in order that the reciprocating engine might be used at any speed. Each kind of engine was thus adapted to the work which suited it best. The reciprocating engine did for slow speeds, while the turbines came into play progressively as the higher speeds up to the maximum were required. They could, moreover, be equally well arranged for going astern, and the combination of the two then made manœuvring almost as easy as with ordinary twin screws. An effective horse-power astern of 75 per cent., or more, of that when going ahead could thus be obtained.

The author's design of turbine consists of a series of flat moving rings, varying in number according to the requirements, and fitted on a single shaft. These rings are placed between circular discs whose rims fit into grooves on the inside of the casing. The shaft traverses these diaphragms through bushes, which allow but little play. Elsewhere, the clearance between the moving and the fixed parts generally exceeds 3 millimetres, and can even be as much as 5 or 6 millimetres without causing trouble. With this arrangement, and by using the work by "impulse" instead of work by "reaction," it has been sought to obtain an engine using as little steam as possible, simple in construction, needing but little care in working, and capable of running for a long time with but little wear and tear. which, although inevitable, can yet be reduced to a very small amount. The loss of steam is entirely confined to the clearance allowed around the shaft. Moreover, the live rings are so constructed as to be very light, and this is of advantage in reducing the gyroscopic effect which comes into play when the vessel pitches. A longitudinal section of the Rateau turbine was shown. It was taken from the one installed on Messrs. Yarrow's boat.

The paper included some valuable details of the application of these turbines to the French torpedo boat, No. 243, and a boat built by Messrs. Yarrow and Co., in which the author's system of turbines was installed. It was mentioned that there are at the present time, either in use or in process of construction, over 50 turbines of the Rateau design, with an aggregate of 25,000 h.p., of which 6,200 h.p. are used for ship propulsion, 950 h.p. for turbine pumps, and 760 h.p. for turbine fans.

The author stated, in conclusion, that steam turbines can be made practically equal to reciprocating engines for propelling ships at high speeds, but in order to obtain their full effect, they must be mounted upon shafts very slightly inclined, and, if possible, with only one propeller on each shaft. The necessity for having horizontal shafts leads to a more sudden rise in the hull aft than is usual when reciprocating engines are installed. Hence, hulls constructed for reciprocating engines are not generally suitable for steam turbines. It must not be concluded from the fact that, *cæteris paribus*, a higher speed is not obtained by merely substituting turbines for reciprocating engines, that the former are therefore inferior to the latter. A new form of propelling engine obviously calls for new lines of hull. At reduced speeds, the turbines are not economical, and they are inconvenient for going astern and for manœuvring, but this drawback can quite well be remedied by combining turbines with a reciprocating engine, working a special shaft and mechanically independent of the turbines. Another arrangement, different from that in the Yarrow boat, whereby the reciprocating engine would supply about 40 per cent. of the total power, would give an increase of 15 to 20 per cent. of the power obtained with a reciprocating engine alone, besides having the general advantages characteristic of turbines.

Sir William White said the paper was remarkable for the frank way in which M. Rateau, though the inventor of a new form of rotary engine, had set out both disadvantages and the advantages. It formed a sub-

stantial addition to our knowledge, and they must acknowledge the generosity of Mr. Yarrow in allowing the results to be published so soon after they had been obtained. He thought there was no need to accept 20 knots as the lowest speed for which turbines were suitable; they could, he thought, be employed for much lower ones. It was an interesting fact that this paper should have been read on the day on which it was announced that the Cunard Company had decided to adopt turbines for their swiftest and largest steamers.

Mr. A. A. Campbell Swinton said that it might be inferred from a statement in the paper that M. Rateau was the first to put the reversing turbine inside the casing of the main turbine, but the first turbine made for purposes of marine propulsion by Mr. Parsons had this arrangement.

Papers, subsequently read by Mr. J. Bruhn, D.Sc., and Mr. A. W. Johns respectively, dealt with "Some points in connection with the Transverse Strength of Ships" and "The Normal Pressures on Thin Moving Plates."

ANTI-FOULING COMPOSITIONS.

Anti-fouling compositions and the protection of the internal parts of vessels from rust were chiefly considered in Mr. A. C. A. Holzapfel's paper. The former were dealt with in two classes: (1) Varnish or enamel compositions; (2) grease compositions.

The author was of opinion that the time had come when manufacturers and consumers should combine to standardise these compositions with a view to ensuring a uniform and reliable article. He had thoroughly satisfied himself that the principal cause of the efficacy of compositions was due to the fact that the mercurial and copper compounds they contained formed, by contact with sea water, a very thin layer or film of chloride solution of the respective metals, and that these chloride solutions were destructive to the organisms which tried to attach themselves to a ship's bottom. These organisms consisted chiefly of spores, larvæ, etc. The chloride solutions of copper and mercury had the effect of coagulating albumen, and it was probably this which caused the destruction of the organisms at the moment they tried to attach themselves to the bottom of a vessel coated with an effective composition.

Comparing the two classes of composition and taking everything into consideration on the score of economy and speed, the author considered that varnish paint would, in the long run, prove to have the advantage. He remarked that bronze propellers should invariably be painted with anti-fouling composition.

FIRE PREVENTION ON BOARD SHIP.

The concluding paper by Mr. Edwin O. Sachs, dealt with the important question of "Fire Prevention on Board Ship." Ships used exclusively or mainly for passenger trade, ships that solely or mainly carry cargo, and ships that carry both passengers and cargo, appeared to the author, to be the three great divisions of commercial shipping, as seen from the fire point of view.

Regarding constructional safeguards, the author considered the primary safeguard in design to be the one which was now being generally adopted on land, namely, that of dividing the ship into a maximum number of fire-resisting compartments. The primary safeguard against spread of fire in all ships of all classes would be their division into the largest number of small fire risks practicable with the work of the ship, and this number could and should far exceed the number of divisions made in order to obtain water-tight compartments.

Turning to the safeguards in the application of materials in the construction of vessels, he considered the reduction of combustible material to a practical minimum to be an essential. For the passenger ship this should be compulsory, and only wood of the non-inflammable description should be used. The "non-inflammability" of wood was a problem which the author considered had been solved commercially.

Regarding safeguards and equipment, the two forms of equipment in respect to which a great deal more attention should be paid were: (1) the protection of the hot steam piping, and (2) careful electric wiring. He advocated that the steam pipe should have additional protective covering beyond its ordinary isolation covering, in the form of a wire guard in all exposed places, so that anything lying right up against it did not touch the pipe or pipe coating, *i.e.*, that there should be an air space intervening.

In all classes of ships, he considered that the safeguard of a fire patrol—as practised on land in the Liverpool warehouses, with regular inspection—should be practised more particularly in the holds and out-of-the-way corners of the ship. It was pointed out that a ship's fire on the sea is not a rarety. In 1903, according to Mr. Harold Sumner, of the Liverpool Underwriters, there were over 300 fires on record for the past twelve months, in ships of over 500 tons register. Of these, 108 were of a serious character.

SHIPBUILDING NEWS.

First Quarter's Shipbuilding.

In last month's notes we referred briefly to the output of the first shipbuilding quarter of the year. Since then the returns from the various districts show that the production of the whole kingdom in the three months, from January to March, 1904, was 300,800 tons, of which 168,900 tons were in England, 102,400 tons in Scotland and 29,500 tons in Ireland. This compares not unfavourably with last year from the shipbuilders' point of view, and the second quarter has opened with a considerable improvement in the industry. Since our last comments a large number of contracts have been booked, and the prospects of the shipbuilder have changed for the better. In Scotland, for instance, it is computed that in March the new contracts booked were for about 50,000 tons, and that during the quarter some 30,000 tons more were booked than were launched. It is true that the work is very unevenly distributed, and that a considerable number of the shipyards entered the second quarter with little or nothing on hand. Still, the district, as a whole, is benefited, and the number of unemployed shipyard workers is reduced. In the North of England the contracting has been still more extensive, and yards which were almost, if not entirely, idle in the closing part of last year are now actively employed.

Shipbuilding Prospects.

This is so far good, but the prospect for shipowners has not improved. During the three months, January to March, some 200 to 250 merchant steamers have been ordered from British builders, representing a carrying capacity of say, a million and a-quarter tons. The trouble in the immediate future will be how to find employment for them. The world's shipping has not been reduced by losses or withdrawals in any way commensurate with the additions now being made to it, while the world's commerce has declined and is declining, as it always does in the periods of depression which follow a boom. As has been already said here, the war in the East has caused some gaps in the streams of ocean carriers; but it has also suspended altogether a good deal of ocean traffic with Japanese and Asiatic-Russian ports. The restriction of trade is greater than the withdrawal of Russian and Japanese shipping. No doubt there is a good deal of tonnage being employed both by Russia and Japan for the conveyance of coal to the Far East at payable freights. In some cases there may be long detentions, but in most cases the difficulty with these vessels will be to get homeward cargoes. But against these diversions of tonnage from normal avenues of employment, we have now to look forward to the new tonnage—very largely of the "tramp" order—that will be put into the water during the remainder of the year. Meanwhile, there is no probability of further reduction in the cost of new ships. Steel plates are £5 15s., less five per cent. in Scotland, and £5 12s. 6d., less two and a-half per cent. in the North of England, and with the growing understanding among steel manufacturers are more likely to be dearer than cheaper—unless American or German stuff comes in. And wages can hardly be lowered when the order books are full.

Lloyd's Returns.

The quarterly shipbuilding returns of Lloyd's Register differ as usual from the records collected from the shipbuilders. As regards the work "under construction" they show that the new quarter began with merchant shipping on hand to the extent of 398 vessels and 988,664 gross tons as compared with 425 vessels, and 974,686 gross tons at the corresponding date in 1903. The total is about 90,000 tons more than at the beginning of January. Lloyd's figures, however, do not include vessels booked but on which work had not actually begun at the end of March. The warships under construction in addition are 74 vessels of 377,115 tons displacement.

The Cunard Commission.

The Commission of Inquiry appointed by the Cunard Company have decided that the turbine should be adopted, and that four shafts and four sets of turbines should be preferred to three. The Commission give many data as to the results of the various experiments made which led to their conclusions. The advantages and disadvantages of the turbine system are discussed in their report, but little saving of weight or area is claimed. The machinery of the two new ships to maintain under all weather conditions a mean of 65,000 i.h.p., will, it is estimated, be only 300 tons lighter than with reciprocating engines; but the Commission advise the Company not to rely on this saving to the extent of adding such 300 tons to cargo or other accommodation, but to hold it in reserve in design for machinery. One important disadvantage dwelt upon is the lack of economy at low speeds; but as the new Cunarders will always run at a uniform speed of 24½ knots, this should be considered a minimum in proportioning the turbines, so that at that speed the greatest power will be secured, and then the coal and steam consumption should be superior to reciprocating engines. In the trials of the English Channel turbine-propelled vessels at full speed these showed an economy of two per cent. over reciprocating engines. The Commission say that this result cannot be accepted as final, because there are several factors influencing efficiency which cannot be eliminated, such as the form of the screw propellers, the form of the stern of the ship and the distance of the propellers from the hull, etc. Economy, however, will result from the use of the turbine by the reduction of the staff in the engine-room, and by the absence of lubricating oil in the exhaust steam.

Shafts and Propellers.

The Commission recommend four shafts not only because four screws will give a higher efficiency, but because it is imprudent to divide the power through a fewer number of shafts. The Commission considered the power necessary to give the sea-speed of 24½ knots with various forms of hull, and although 24½ knots can be realised at sea under normal weather conditions, it is necessary to have a considerable margin of power to ensure that this rate will be maintained under adverse conditions. For this reason 25 knots will be attained on an extended trial trip. Consequently, with three shafts, the power transmitted through each would require to have been about 25,000 i.h.p., whereas, with four shafts it will not much exceed 18,000 i.h.p. There is also to be considered the question of the size of the turbine and the advantage of limiting the number of revolutions per minute of the screw propellers. Large diameter improves the sea-manœuvring quality, and the Committee started with the proposition that the revolutions should be limited to 140 per minute. This is considerably more than with reciprocating engines, but it compares with 300 to 500 revolutions at which smaller turbine-driven vessels are now run. The design of turbine will differ slightly from that in other ships; they will require to be of greater diameter to give the power, and the peripheral speed will consequently be very high, but no greater than with existing turbines.

Cunard Turbine Engines.

It is proposed that there shall be one go-ahead turbine on each of the four shafts, which will be equidistant from each other. The high pressure turbines will be mounted on two outside shafts, which will have the propellers at a considerable distance from the stern of the ship, and thus there will be the minimum of disturbance to the flow of water to the two inside propellers, which will be placed right aft in the usual way. On each of the two inside shafts there will be two turbines. On each there will be two low-pressure turbines for driving the ship ahead. The other two will be for astern motion. The power for ahead motion is to be in two steam units, each with one high and one low-pressure turbine, giving the best expansion of steam; but should there be any breakdown of one set the three remaining shafts may be run, and thus only one-fourth of the power will be unavailable. One advantage of the four screws and of the two central shafts being fitted with astern driving turbines is that the power for driving astern will be equal to one-half the forward motion power distributed through two shafts.

Experimental Tanks.

The Institution of Naval Architects are taking steps to follow up practically the appeal which Sir William White made at the recent Congress to shipowners and shipbuilders on the subject of experimental tanks.* About three years ago at Glasgow, Mr. Yarrow proposed that an experimental tank should be established under the auspices of the Institution of Naval Architects. A committee was appointed to give effect to this proposal, and in March, 1902, a report was submitted to the Council, and the latter authorised the committee to take the steps necessary to raise the sum of £15,000, which, it was estimated, would suffice to build and equip a suitable experimental establishment in connection with the National Physical Laboratory in Bushy Park, where a suitable site could be found. There was, however, in some quarters a conviction that it was preferable to have experimental tanks for testing ship models closer to the great shipbuilding centres, and there was also a fear that in any establishment for testing ship models, representing competing designs or new ideas, there might be a serious chance of leakage or improper use of information. Sir William White did not concur in this view, but he does not think it wise to establish a single tank in any locality. He rather advocates the establishment by each of the large builders of experimental tanks of their own, such as that which Messrs. Denny have for twenty years had at Dumbarton, and as John Brown and Co., Ltd., have now at Clydebank. But what Sir William White advises, and a committee of the Institution of Naval Architects are about to endeavour to carry out, is the establishment of a tank in connection with the National Physical Laboratory for purely research work.

Sailing Ships.

In an interesting address to the Royal Philosophical Society of Glasgow at the beginning of April, Mr. Robert Caird, LL.D. (of the great shipbuilding firm) dwelt on the developments in the means of communication by sea during the nineteenth century. In the course of his remarks he said that the opening of the Suez Canal, among other things, promoted the gradual but unrelenting supersession of sailing ships by steam even on the longest routes, due in great measure to the continuous improvements in marine engineering, tending to increased economy of fuel, to the multiplication of coaling stations and to cheap conveyance of coal to distant points. The statistics of last year show that while 622 merchant steamers of over 2,200 tons average were built in this country, only seventy-two sailing ships of 700 tons average were added to the register. Only one-twenty-eighth of the new tonnage was sailing. But while what Mr. Caird says is quite true we do not believe that the life of the sailing ship is done, or ever will be done. Nor do the sailing ship-owners of Britain, Germany and France, who have formed an International Union for the preservation of each other from each other's attacks on the freight market.

Shipping in 1903.

In the course of a restrospect of shipping covering 1903, the editor of the "Shipping World Year-Book" writes: The depression to which we referred when reviewing the position a year ago has pressed still harder upon shipbuilding and shipping during the year 1903. Although the volume of oversea trade was the greatest in the history of commerce, freights have never been so low as during the last twelve months, and this remark applies practically to all shipping trades, in home and foreign seas and countries, with exceptions in the passenger and emigrant business. It goes without saying that this state of things has deterred many shipowners from ordering new tonnage. The best-informed have bided, and are still biding, their time, until the bottom price is touched. Moreover, prices of shipbuilding materials have been well maintained throughout the year; nor have the wages and earnings of artisans and labourers been much reduced; while British yards on the whole have been employed beyond expectation, beyond parallel or comparison (war vessels excluded) with the yards of any other country, and have turned out tonnage at lower prices than have ever before been booked for a similar class of ships. The world's output of war and merchant tonnage during 1903 aggregated 2,730,205 tons, and the contribution of British yards to the whole is 1,424,888 tons. The figures for 1902 gave a total output by the yards of the world of 2,733,024 tons; the contribution of the yards of the United Kingdom, 1,654,644 tons, leaving 1,078,380 tons as the output of the other shipbuilding countries of the world.

It is true that British yards show a decline in output equal to 13·3 per cent., while foreign and colonial yards have an increase of 20 per cent.; the world's production of shipping showing the small falling off of 0·09 per cent. But it must be explained that the more favourable position of foreign yards is accounted for by their largely increased output of fighting tonnage, and the falling off in the Royal Dockyards figures from 51,560 tons in 1902 to 28,290 tons in 1903.

Notable Launches.

Since the last instalment of these notes appeared, Messrs. Harland and Wolff, Ltd., launched the large twin-screw steamer *Dunluce Castle* from the south end of the Queen's Island. The new liner is 475 ft. long by 56 ft. 6 in. beam, and about 8,380 tons gross. She is destined for the intermediate service of the Union-Castle Mail Steamship Company, Ltd. She will have large cargo-carrying and refrigerating capacity. Messrs. Hawthorn, Leslie and Co., Hebburn-on-Tyne, have launched the first turbine passenger steamer for service on the Canadian lakes. The vessel has been built to the order of the Turbine Steamship Company, Ltd., of Hamilton, Ontario, and has been specially designed for the new service between Hamilton and Toronto.

* See page 425.—Ed.

OPENINGS FOR TRADE ABROAD.

Belgium.

Tenders are invited for the construction of a new dry dock, etc., at Ostend. The estimated cost is £120,000: a deposit of £12,000 is required to qualify any tender, which will be received up to the 24th July at 1, Square Stephanie, Brussels.

Spain.

The Santander and Bilbao Railway Company have been authorised to establish a double line between Bilbao and Las Arenas. A Royal Order has authorised the Government to grant a concession, without subvention, for a metre gauge steam railway from Colmenar de Oreja, through sundry towns to Alcázar de San Juan.

Tenders are in demand for the supply of a rotary dredging machine, three lighters, and a floating pump, for use in the Huelva port works. Tenders will be received up to the 8th June, a deposit of 5 per cent. is required to qualify tenders. Persons tendering must state whether the material they propose to supply is new or secondhand. Tenders will be received up to May 9th next, at the office of the Director-General of Public Works in Madrid, for the execution of the work of prolonging certain moles and for other harbour works at Tarragona, at the upset price of 2,339,000 pesetas (or about £66,800). A deposit of about £3,370 is required to qualify tenders.

Nicaragua.

The Government of Nicaragua has a corps of civil engineers surveying the line for a railway from San Miguelito, on the south-eastern shore of Lake Nicaragua, to Monkey Point, on the Caribbean Sea. This line was surveyed for an English syndicate, whose surveyors reported the route as favourable to railway construction, especially the eastern half. The route is projected through a region without population and the through traffic will not pay even a low rate of interest on the cost. It is stated, however, that the President of the Republic will build this railway if possible. With capital to keep the work going the railway can be completed in about two years from its actual commencement.

Portugal.

The plan and estimate, amounting to about £26,183, for the construction of the fourth section of the Southern Railway, between Tavira and Cacella, 12,000 metres, have been approved and working operations sanctioned.

Italy.

The Italian Navy Department has given notice that in future foreign firms will be allowed to compete in all contracts for armour plates and naval supplies, as the Tariff affords the home industry the necessary protection.

Cape Colony.

Bills will be introduced into the Cape Parliament during the ensuing session authorising the construction and working of railways from Isinuku to Umtata, and St. John's to Kokstad. The Council of the Municipality of Kalk Bay will introduce a Bill authorising the Council to supply electricity for lighting, heating, and power purposes for general, industrial, and domestic purposes.

Natal.

A correspondent of the Board of Trade writes:— "It has been known for many years that deposits of iron of excellent quality exist in the northern districts of the Colony, and there is reason to believe that a judicious investment of capital would result in the development of a very important industry there." This would in time necessitate a large quantity of mining gear, tools, etc., for the development of such an extensive property.

Argentina.

The Government has been authorised to construct, directly or by means of private enterprise, in accordance with the existing laws, a large number of bridges and roads throughout the Republic. Among the former may be named the bridge crossing the Riachuelo de Barracas in continuation of the Avenida in Buenos Ayres, at a cost of $300,000 (national currency); a bridge over the River Colorado in el Paso Morales, $100,000; a light cart road bridge over the River Corrientes between Santillan passage and the crossings of the river by the railway line, $540,000; construction of a cart road bridge over the River Mendoza at Palmira, $250,000. Tenders are invited for the supply of twelve locomotives, 100 closed wagons, and 100 open trucks for the Central Northern Railway of Argentina, in accordance with plans and conditions drawn up by the Direction of Ways of Communication.

China.

Nearly all parts of China are greatly in need of better facilities for supplying the people with pure drinking water. In all the city of Foochow, with its million of inhabitants there is not a single pump, windlass, or other mechanical appliance for raising water from wells or bringing it from the river to supply the city. There is no public water system in all Southern China.

Egypt.

The Egyptian Railway Administration is about to spend 3,000,000 Egyptian pounds on new works and materials. It is proposed to construct two lines, instead of the present single one, from Minieh to Wasta, at a cost of 600,000 Egyptian pounds; to extend all the lines on the system, chiefly the line to Rosetta, to build goods stations, etc.

CATALOGUE COVER . . . . DESIGNS . . .

MESSRS. FRANCIS T. BARRETT AND COMPANY, of Lewisham, are responsible for the first of the designs shown this month, which is a happy combination of their art modelled panel work with half-tone illustration, and is used for the cover of Messrs. Lassen and Hjort's pamphlet on the Bruun-Lowener Water Softener. The design is printed from a single half-tone block, in which the wording, thrown into such strong relief in the model, is faithfully reproduced. The photograph represents a cylindrical softener, capacity 3,000 gallons per hour. The plant is installed at a spinning mill and the water treated in the apparatus is reduced from 30 to 5 degrees. The illustration shows clearly the chemical reservoir and the oscillating receiver. The pamphlet is well printed, and has some very interesting particulars of the Bruun-Lowener Water Softener, which we are informed, has been adopted in over a thousand works in all parts of the world.

Messrs. Tangyes, Ltd., are issuing a complete series of catalogues showing their latest types of machinery. Of these, catalogues of special steam pumps, hydraulic machinery, oil and gas engines, duplex steam pumps, factors' goods, general pumping machinery and marine-type petrol engines have already been issued. The latest catalogue is an admirably printed list of steam engines cancelling all previously issued. It includes numerous half-tone illustrations, and tabulated particulars of dimensions, etc., accompany the general descriptions. An effective cover has been designed for this in which all the lighter parts are done in silver, while bronze blue is effectively used for bordering the letters and for the shadows which serve to throw out the word Tangyes.

THE PROPOSED THAMES DAM.
In this drawing Mr. Barber has outlined the barrage as it would appear when complete.

THE PROPOSED DOCKISATION OF THE THAMES.

IS the dockisation of the Thames to prove a panacea for the disabilities of the Port of London? Mr. T. W. Barber, M.Inst.C.E., answers the question emphatically in the affirmative. He boldly proposes to dam the river at Gravesend, thus converting the Thames between that point and Teddington into a huge freshwater lake, forty-six miles in length, maintaining Trinity House high-water level at all times.

An inspection of the illustration on the opposite page shows that the proposed dam bears considerable resemblance to the Nile Barrage, while from the accompanying cross-section it will be seen that it is proposed to make the dam a valuable link for the purpose of locomotion, a wide road running along the top and a tunnel being provided beneath for railway traffic. The structure proposed consists mainly of mass concrete and granite facing, and provides for a very complete system of sluices and locks.

Part of the water flowing over the dam would provide electric power for working the locks, which are four in number, and also a complete equipment of power capstans and gear. The whole of the traffic would be regulated from a pilot tower forming a permanent feature of the barrage.

One of the first considerations naturally bound up with this scheme is the health of London, but it is urged that the action of the tides upon the Thames so far from being health-giving is entirely detrimental. Mr. W. P. Birch has shown that the action of the tides keeps the river continually saturated with about forty-five days' soilage, and, says Mr. Barber, "they back up twice daily the natural drainage of the river for five hours, and keep it in solution and circulation for forty-five days before removing it, the effect being exactly similar to backing up in a sewer."

In place of this, Mr. Barber's scheme would stop all tides at the dam, the enclosed water area having numerous affluents—chiefly Teddington Weir—and only one outlet. Thus the water would have a slow downward current, never reversing, so that everything entering it would pass downwards to the dam. It is thus proposed to obtain by one work a navigable depth of water varying from 65 ft. at Gravesend to 32 ft. at London Bridge without dredging or any interference with the river bottom or banks such as that proposed by the Royal Commission on the Port of London, which Mr. Barber says cannot be carried out.

The cost of the dam is set down at £3,658,000, including compensations and other contingencies, while the annual saving in dredging, repairs, cost of operating dock entrances, time of vessels, towage, etc., is estimated at £850,100 annually. It is also urged that the scheme will form the basis of an effective water supply, obviating an expenditure of £24,000,000 in this direction; also rendering unnecessary an expenditure of £30,000,000 on the purchase of docks, and £7,000,000 on improving the docks and dredging river—total, £61,000,000.

The immediate advantages to shipping promised by Mr. Barber may be summarised as follows: The possibility of ships approaching London Bridge at all times and of remaining at one level for loading or unloading alongside the quays, an immense saving consequent upon the dock entrances being left open; absence of mud from the docks and back waters; prevention of floods from exceptional tides; reduced cost of towage and repairing banks; control of the river, etc., and greatly increased safety of navigation. Owing to the removal of all vessels from mid-stream it is anticipated that there would be excellent opportunity for pleasure traffic, boating, sailing and fishing, while last, but not least, in this attractive list may be mentioned the possible provision of an efficient steam-boat service with fixed piers.

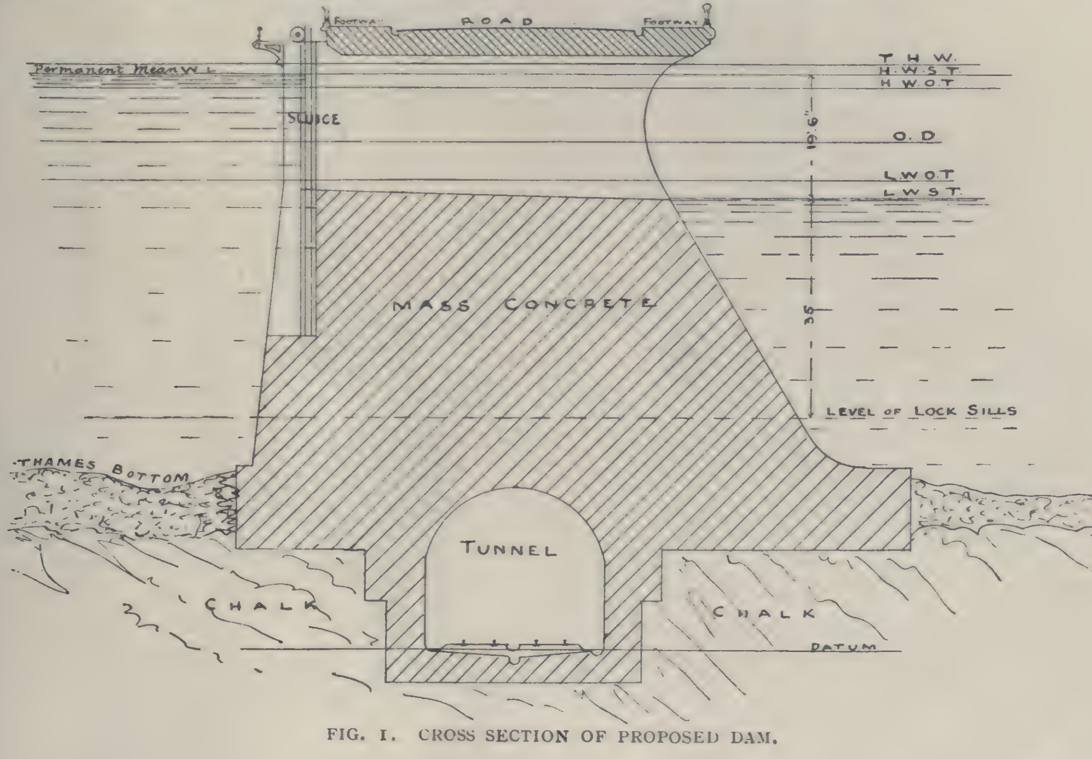


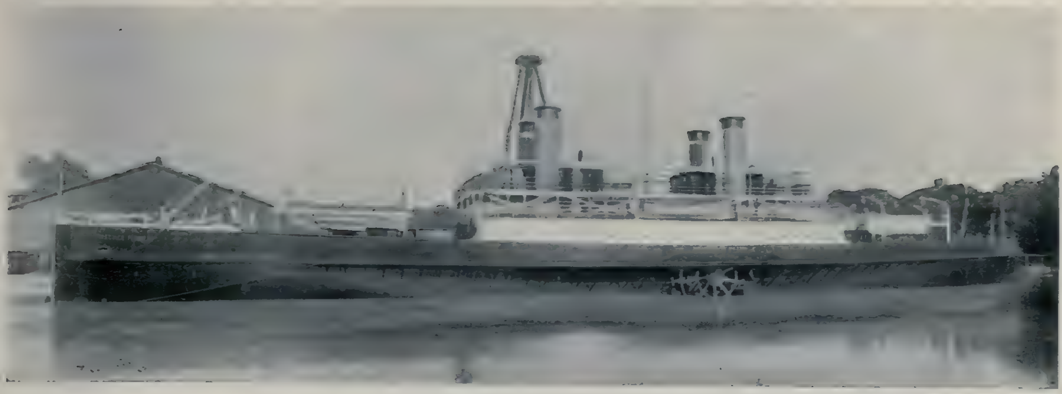
FIG. I. CROSS SECTION OF PROPOSED DAM.

By the courtesy of the United Service Gazette.]

THE FRENCH FIRST-CLASS BATTLESHIP "CARNOT," 11,986 TONS; 15,000-I.H.P.; SPEED, 18 KNOTS.

ARMOUR PROTECTION: Water-line complete belt, 17·7 in. tapering to 10·8 in. and 8 ft. 3 in. deep; upper belt, 3·9 in., for a breadth of 3 ft. 5in.; turrets for heavy guns, 14·6 in.; turrets for secondary armament, 3·9 in.; armoured deck, 2·7 in., curved behind belt.

ARMAMENT: Two 12-in. in turrets, one forward and one aft; two 10·8-in. in turrets, one on each beam; eight 5·5-in. in separate turrets, one on each quarter, one on each bow, and two on each beam; four 9-pounder, twelve 3-pounder, and eight 1-pounder quick-firing guns. Four Torpedo-tubes, two submerged.



ONE OF THE NEW RAILWAY FERRY BOATS.

THE GJEDSER-WARNEMÜNDE FERRY BOATS.

By Our Berlin Correspondent.

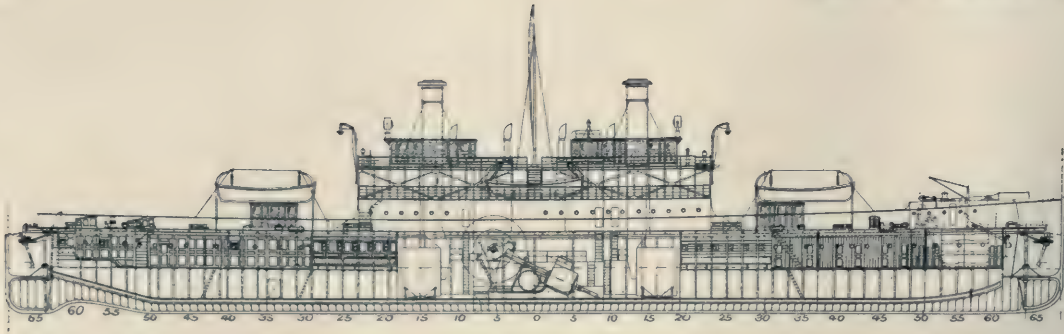
THE ferry boat line, 42 kilometres in length, between Gjedser, Denmark, and Warnemünde, Germany, which was opened on October 1st last year as part of the Berlin-Copenhagen railway line, comprises four ships, two of which belong to the Danish and two to the German State. Each country possesses a wheel steamer and a twin stern-screw steamer. The boats are provided on deck with rails intended for receiving whole railway trains, both with passengers and goods; the wheel steamers, having only one track, are specially intended for passenger service, whereas the screw steamers, provided with double tracks, will in the first place be utilised for carrying goods. In winter, however, during the ice period, the screw steamers are to be employed for the total traffic.

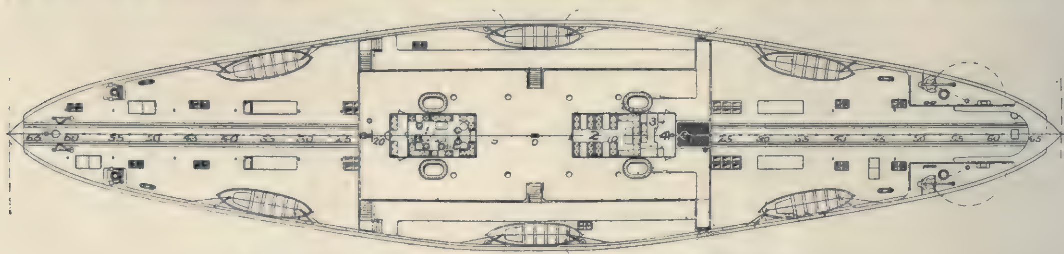
Travellers from the European Continent to Copenhagen and *vice versâ* are thus offered the advantage of being conveyed direct from Germany to Denmark without their being compelled to leave the train, and without their luggage having to be transhipped. The railway trains are led direct up to the ferry boats, to be conveyed over sea without the luggage being unloaded. Moreover, all the goods sent to Denmark and Sweden may now be carried direct on a much shorter way; in fact, the new line is more than 300 kilometres shorter than the existing ferry boat line from Jutland to Seeland, thus admitting of a material saving both in time and freight. In order to maintain the ferry-boat service throughout the winter, the screw ferry boats are designed as particularly powerful ice breakers, capable of clearing the ice obstructing the harbour under any circumstances.

Of the four boats above mentioned, three were built by the firm of F. Schichau, Elbing. These ships are made from the best class Siemens-Martin steel, in accord with the regulations of the German-Lloyd. The main deck is closed in front by a forecastle, provided with a mechanically moving passage for railway cars. In this way the boats are enabled to sail as soon as the railway cars have been transported on board the ship. On arriving, the train may immediately be transported on land through the movable forecastle, and can at once proceed on its way. The length of track is about 80 metres in the wheel boats and 125 metres in the screw boats, the ferry boats thus being able to receive "D-trains," passenger or freight trains of corresponding length. As the ferry boats are not able to turn round inside of the harbour, they are specially equipped in order to leave the latter backwards and to turn outside of it.

The two wheel boats have a triple expansion steam engine each of 2,500 i.h.p., developing the power necessary to drive the ship at the speed of 13·5 knots at about 45 revolutions per minute, and a coal consumption of 0·75 kilogrammes per h.p. hour. The three steam cylinders are arranged one beside the other, the low-pressure cylinder being midway. The engines are provided with surface condensers, with air and circulation pumps, steam-reversing device, and the necessary feeding and Lenz pumps. The boiler plants comprise four cylindric ship boilers each, two of which are located in each vessel in a common boiler room. For cases of emergency a small vertical boiler is provided.

The machine plant of the screw boat *Mecklenburg* consists of two vertically arranged triple

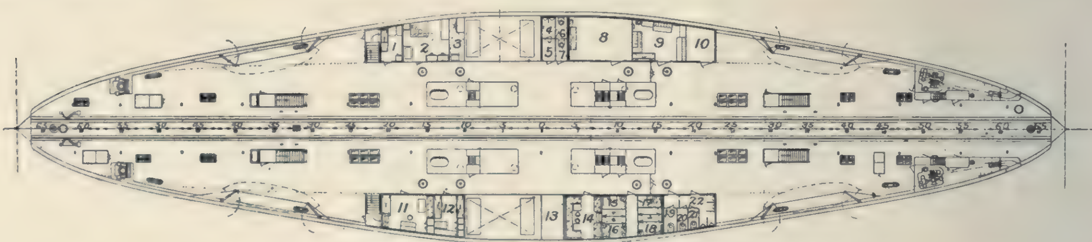




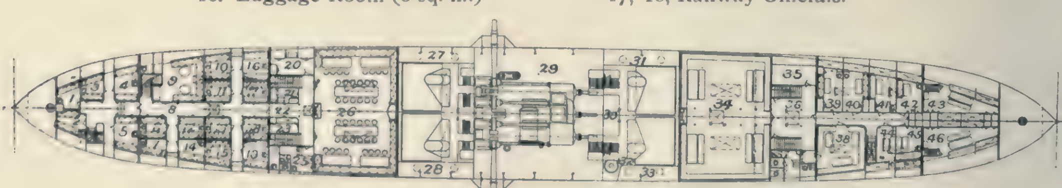
1. Ladies' Saloon.
2. Smoking Room (1st and 2nd class).
3. Chart House.
4. Rudder House.

expansion machines, developing a total amount of about 2,500 i.h.p., with about 80 revolutions per minute, and a consumption of coal of 0·75 kilogrammes for i.h.p. hour. The boiler plant comprises two cylindric double boilers, designed and arranged in the way usual with ships, being installed in a common boiler room in front of the machine room. There is also a small vertical boiler for emergency purposes.

The boats are lit by electricity throughout, two projectors serving to illuminate the sea at night.



1. Cook.
2. Kitchen.
3. Pantry.
8. Luggage Room (18 sq. m.)
9. Letter Room.
10. Luggage Room (6 sq. m.)
11. Captain.
12. Three Kitchen Girls.
13. Lamp Room.
14. Smoking Room.
15, 16, Custom House Office.
17, 18, Railway Officials.



1, 2, 3, etc. First and Second-class Passenger Cabins.
9. Ladies' Saloon.
20. Pantry.
21. Steward.
23. Stewardess.
26. Dining Room (1st and 2nd class).
27, 28, 31, 32. Coal.
29. Machine Room.
30. Boiler Room.
34. Saloon (3rd class).
35. Pantry.
38. Ladies' Saloon.
39, etc., etc. Machinists, Stokers, Sailors.

A FLOATING EXHIBITION.

WE have pleasure in calling attention to the Imperial Floating Exhibition —a novel idea which has been formulated with a view to the development of British trade abroad.

The idea, as set forth in an interesting little brochure, published by the Manager of the Exhibition, Mr. John Henderson, is to charter a large steamer, fit her out with samples of goods manufactured by the best British industrial firms, and send her on a voyage round the principal ports of the Empire, China, Japan, and, possibly, one or two other countries important as markets for British products.

Accompanying the steamer will be a representative of each firm exhibiting, and a competent staff of officials for organising and carrying out the details of the tour. A fixed amount of clear space will be set aside for each participant. At each port of call the Exhibition will be "opened" by a prominent official, and the members of the local Chambers of Commerce, the leading traders, and others are to be entertained on board. Advance agents of the Exhibition, assisted by the local press, will see that the advent of the Exhibition is made widely-known throughout the trading community of each country.

AUCKLAND.

VICTORIA BRIDGE, BRISBANE.

The objects the organisers have in establishing the Exhibition are: (1) The promotion of inter-Imperial commerce; (2) The personal introduction of the seller to the buyer; (3) To provide a means by which British manufacturers can fully investigate the peculiar conditions and requirements of individual markets. (4) The advertisement of British industries by bringing to Foreign and Colonial ports a representative Exhibition of British manufactured articles.

We gather from the pamphlet that limited space will prevent the appropriation of accommodation by two firms representing the same trade. As it seems to us that this would somewhat circumscribe the limits of the Exhibition, we are glad to note that it has been decided to make exceptions to this rule, when it is found impossible to discover one firm capable of adequately representing a particular industry in all its branches. "In such cases," writes Mr. Henderson, "a certain space (necessarily small) will be allotted to the trade, and various manufacturing houses will combine to make the show thoroughly representative."

We are also informed that the steamer to be chartered for the purposes of this Exhibition is the *Lake Megantic*, a North-American liner of some 5,500 tons, The Exhibition ship will probably sail from London during September. There is no doubt but that the Exhibition will be watched with great interest. The accompanying illustrations from the brochure show three of the numerous ports of call.

NAGASAKI HARBOUR.

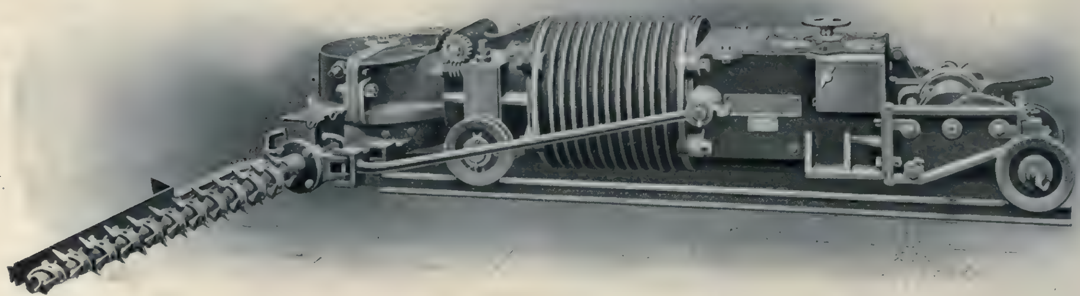


FIG. I. THE PICKQUICK ELECTRIC BAR COAL-CUTTER, WITH ALTERNATING CURRENT ELECTRIC MOTOR, ADJUSTED FOR UNDERCUTTING.

COAL CUTTING BY ELECTRICITY.

IN view of the recent report on the employment of electricity in mines, the "Red Book," issued by Messrs. Mavor and Coulson, Ltd., possesses peculiar interest for colliery owners and managers. It is concerned with Pickquick coal-cutting machines fitted with direct current electric motors, three-phrase motors, and compressed air motors. It is pointed out that the long wall method of working is better suited than any other for machine mining, and is favourable to a large output per machine.

The economies effected by machine mining are summarised as follows :—

(1) The cost of holing is reduced by the large increase of output per man employed.

(2) A large output is obtained from a relatively small face, and the extent and cost of maintenance of roads is reduced.

(3) The cost of timbering is reduced, and the straight and rapid advance of the face facilitates the breaking away of the coal.

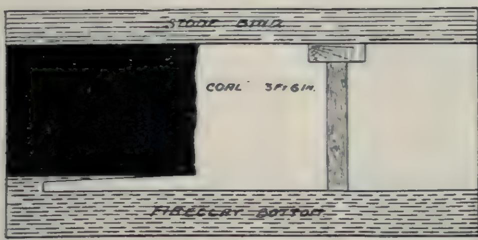
(4) The use of explosives is almost invariably reduced, and is frequently abolished by machine holing.

(5) The percentage of slack is reduced, and the sale price of the coal is substantially increased.

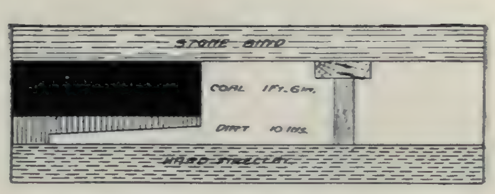
(6) Greater safety to the miner. The machine does the most dangerous and laborious part of the miner's work, and the systematic timbering imposed by machine holing reduces falls at the face, and diminishes the number of accidents and compensation claims. The ratio of accidents to tonnage output has proved to be much lower with machine-cut than with hand-holed coal.

The writer remarks that when the system of electric supply is open to choice, direct current should be selected, as it is the best adapted for driving coal-cutters. When the adoption of alternating current is determined by other considerations, a low periodicity, not exceeding 30 cycles per second, should, if possible, be used. The limitations in respect of diameter, speed of rotation, and complete enclosure of coal-cutter motors are incompatible with the best design in alternating-current motors for higher periodicities. The application of alternating-current motors with closed circuit rotors to the larger sizes of bar coal-cutters for use in thick and medium seams presents little difficulty when the periodicity does not exceed 30 cycles per second, but for the small size machines the use of alternating current is impracticable. Where the supply is alternating it is therefore necessary to interpose rotary converters, or motor generators, in order to transform to direct current for the small machines.

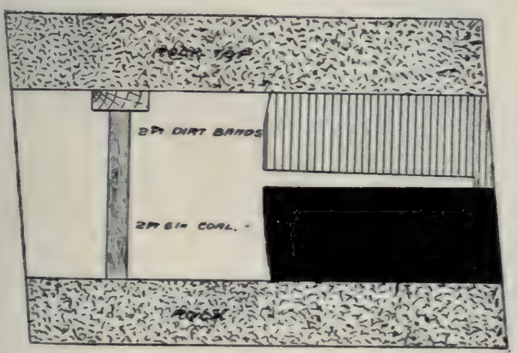
The five parts which make up the Pickquick, viz., the cutter bar, gear head, motor, switch box, and hauling gear, are described in detail, and some interesting diagrams (reproduced herewith) show specimen seams worked by this cutter. We also reproduce a view of the machine fitted with alternating current electric motor, and adjusted for under-cutting.



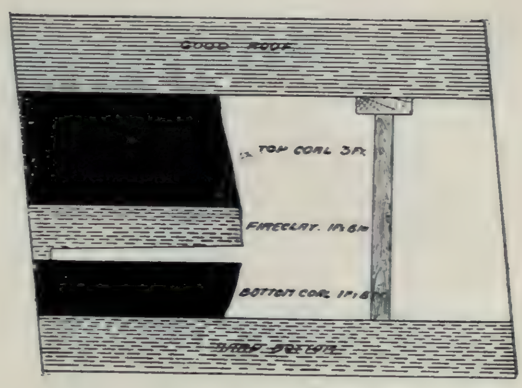
Depth, 600 ft. Fireclay Holing.
Undercut, 4 ft. deep.



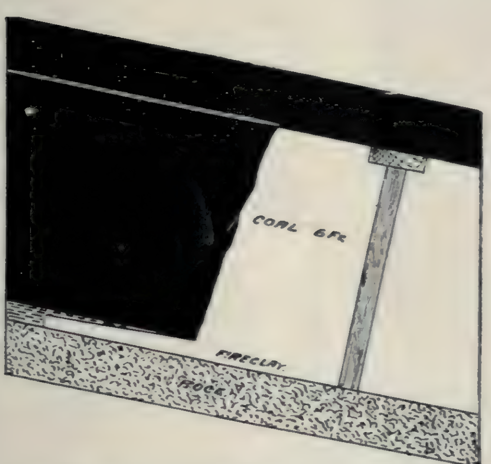
Depth, 800 ft. Coaly Band Holing.
Undercut, 4 ft. deep.



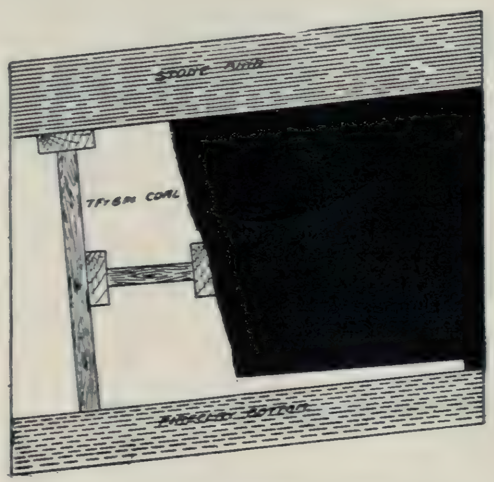
Depth, 1,500 ft. Inclination of Face, 1 in 10.
Dirt Band Holing. Undercut, 5 ft. 6 in. deep.



Depth, 1,200 ft. Inclination of Face, 1 in 9.
Fireclay Holing. Undercut, 4 ft. deep.



Depth, 2,200 ft. Inclination of Seam, 1 in 5.
Hard Fireclay Holing. Undercut, 4 ft. 6 in. deep.



Depth, 2,000 ft. Inclination of Seam, 1 in 10.
Coal Holing. Undercut, 6 ft. deep.

FIG. 2. SEAMS ILLUSTRATING THE WORKING OF COAL CUTTING BY MACHINERY.

A GUIDE-BOOK TO MINING.

Notes on Professor Le Neve Foster's New Text-Book on "The Elements of Mining and Quarrying."

SIR C. LE NEVE FOSTER, D.Sc., F.R.S., has rendered his new text-book,* on the "Elements of Mining and Quarrying," additionally attractive to students by the inclusion of a number of engravings illustrating mining operations as they are actually carried on. One of these shows the use of the wire saw at Maillou Slate Quarry, Labassère, near Bagnères-de-Bigorre, France. Vertical and horizontal cuts are made by the saw, but in the illustration (fig. 2) the horizontal cuts are covered by rubbish.

"The most novel method of cutting stone," says the author, "is one which is in use at marble quarries in Belgium, Carrara and elsewhere. It consists in sawing grooves by an endless cord, composed of three steel wires twisted together, which travels on the rock, and is supplied with sand and water. Fig. 1 represents the arrangement adopted at the Traigneaux Quarry, near Philippeville, Belgium. A, B, C, D, E, F, is the wire cord travelling in the direction shown by the arrows; G and H are the two pits which have been sunk to hold the pulley frames. When the cutting process began, the wire cord would have been running along the line I J; the groove is gradually deepened until it reaches the line K L. After suitable vertical cuts have been made, the block is severed horizontally by means of wedges." Fig. 2 shows the kind of work done by the wire-saw in the Pyrenees.

Discussing other methods of excavation, Professor Le Neve Foster remarks that a machine which will excavate a complete tunnel at one operation has long been a desideratum of the miner. Stanley's machine cuts an annular groove in coal by teeth attached to a cross-bar, which is made to revolve by a compressed air engine. Much of the cylinder of coal within the groove breaks off while the cutting is going on, and what remains can easily be brought down by a single central blast.

With regard to shaft-sinking machines he remarks that in exceptional cases shafts are being sunk by the aid of machines which will cut out a big circular pit. As in the case of small holes, the work may be done by rotation or percussion. Rotary machines are being employed in Germany in some sinkings through quicksand; the machines are big revolving scoops, and several ingenious contrivances have been designed for promoting the speed and success of the operations. Large percussive tools similar in action to those employed in exploratory borings, enable shafts 16 ft. in diameter to be excavated through watery strata without any pumping being required, and the names of Kind and Chaudron will always be associated with this method of sinking. Sutcliffe advocates the use of a machine which will cut a circular groove round the circumference of the proposed shaft, just as Stanley's machine cuts a groove for driving a level. When once a peripheral groove has been made, it is easy to blast away the core.

In addition to such practical illustrations as these there are, of course, many valuable figures and diagrams, and the text is arranged so clearly and scientifically that the work becomes literally what the author intended it to be, viz., a guide book to mining. Professor Le Neve Foster first makes the way easy for the student, and then tells him to diligently visit

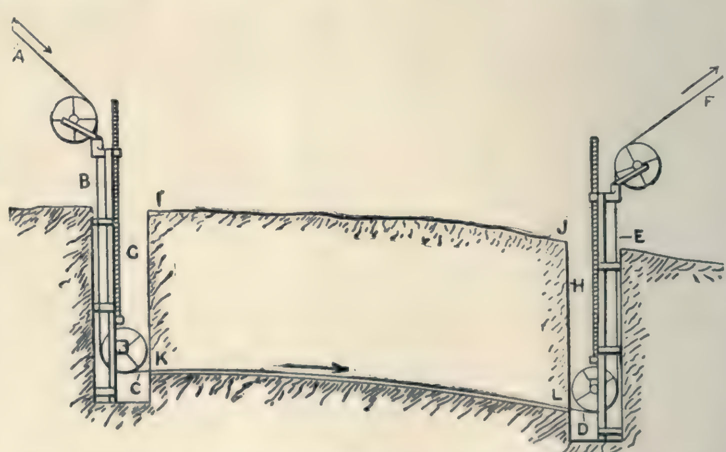


FIG. 1. WIRE SAW, TRAIGNEAUX MARBLE QUARRY, PHILIPPEVILLE, BELGIUM.

* "The Elements of Mining and Quarrying," by Sir C. Le Neve Foster, D.Sc., F.R.S. 7s. 6d. net. Charles Griffin and Co., Ltd.

mines. "A book on mining," he says, "aids the student in acquiring information, explains points which may be obscure, and suggests subjects for inquiry, but without in any way enabling him to dispense with the knowledge which comes from seeing and doing things." The illustrations, nearly three hundred in number, should certainly encourage the student to carry out the excellent advice given.

The work is divided as follows: Occurrence — Discovery — Boring — Excavation —Support—Exploitation —Haulage—Hoisting or Winding—Drainage — Ventilation — Lighting — Access—Dressing—Legislation—Condition of the Workmen—Accidents.

The chapter on legislation is included because mining differs from most other occupations by being regulated by special statutes, and it is especially with an uncongenial branch of the subject like law that the student needs a helping hand. The subject is briefly dealt with as follows:—(1) Classification of mineral workings in the United Kingdom. (2) Statutes relating solely to mines and quarries. (3) Certain statutes affecting mines and quarries incidentally.

The inclusion of a chapter on the condition of workmen in an elementary text-book may surprise some, but the author says he considers that the labour question is of so much importance that the student should have his attention directed to it at the very outset of his career. In this chapter are briefly discussed:—(1) Conditions of labour, (2) Clothing, (3) Housing, (4) Occupational Diseases, (5) Hospitals, (6) Education, (7) Recreation.

FIG. 2. MAILLOU SLATE QUARRY, NEAR BAGNÈRES-DE-BIGORRE, FRANCE.
Where vertical and horizontal cuts are made by the wire-saw.

Professor Le Neve Foster's work offers a marked advance in the preparation of mining text-books, and can scarcely fail to be of corresponding benefit to mining students.

Since the completion of these pages we hear with deep regret of the death of Professor Le Neve Foster, which occurred in London on the 19th ult.—Ed.

NOTES and NEWS.

A New Way of Tapping Water Mains.

A PROCESS valuable to waterworks engineers was recently tested in a practical manner at Snaresbrook, when, by means of the Smith tapping machine, a 24 in. water main belonging to the East London Water Company was tapped and a 12 in. branch attached to it without any interruption of the supply. The main was at the time fully charged at a pressure of about 54 lb. to the square inch.

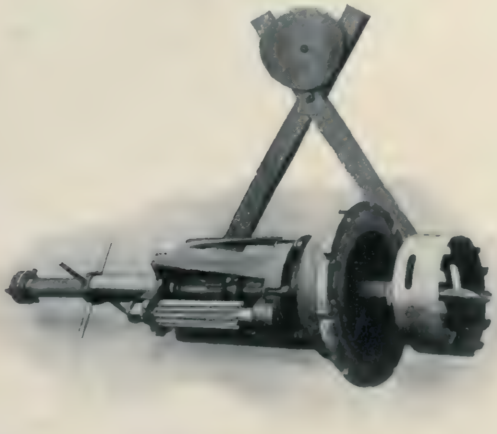
A 24 in. cast iron collar, made in two halves, was first bolted around the main. On one side of this collar was cast a 12 in. outlet, and on the inside of this outlet a clay roll was inserted, the half-inch space between the collar and the pipe being then filled with lead, and thoroughly calked. The joint inside the 12 in. outlet was calked last, this joint being relied upon to make the collar watertight. To the outlet was then attached a 12 in. valve, having a bayonet joint for connection to the collar. This joint was poured with lead, and calked in the ordinary way. The valve had a flange on the other end, and to this flange the Smith tapping machine was attached. The door of the valve was then opened, giving a clear way of 12 in. in diameter. Through this valve the shaft carrying the 12 in. cutter and centre drill was then pushed forward until the centre drill touched the external surface of the 24 in. pipe.

The shaft was then locked to the feed gear, and the operation of cutting the 12 in. disc from the 24 in. main was begun. The shaft of the tapping machine passes through a stuffing box to prevent the water escaping after the cut is made. The cutter was rotated by means of levers, and fed forward until the 12 in. disc was completely cut from the main.

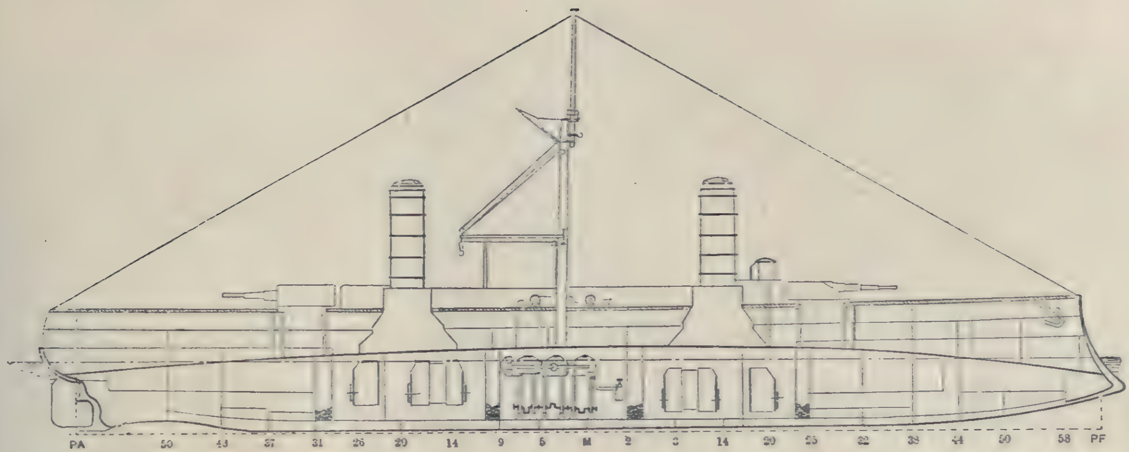
The centre drill shown in cut first pierces the main, and has the effect of centreing the large cutter and holding it firmly in position. As soon as this drill pierces the pipe the water, of course, rushes into the valve and the body of the machine, but cannot get any further, owing to the stuffing box, through which the shaft of the machine works. This water has the effect of lubricating the teeth of the cutter. On the end of the drill there is a thread, which forms a female thread in the cast iron disc that is cut out of the main, thus preventing the disc from dropping into the 24 in. main. The only way that the disc can be removed from the cutter is by unscrewing it. Owing to the curvature of the pipe it will be appreciated that the hole cut has really a larger capacity for the flow of water than if it was cut from a perfectly flat surface. In other words, if this disc is flattened, it would really measure more than 12 in. from top to bottom.

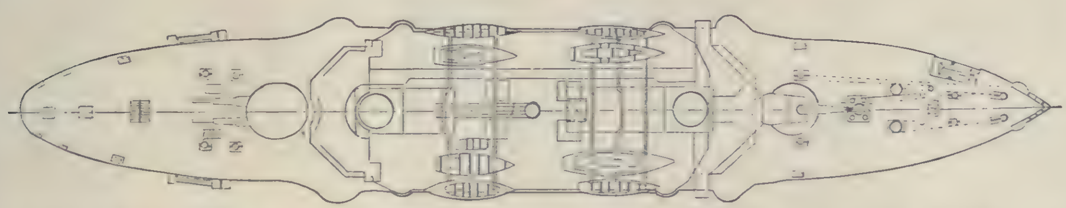
When the cast iron disc had been completely cut from the main, the shaft, together with cutter and cast iron disc, were withdrawn through the valve to the back of the valve door. The valve was then closed, enabling the workmen to unbolt the machine from the valve and remove it without the loss of water. After the machine was removed the valve was partially opened, in order that the borings from the cutter and drill might be removed by taking advantage of the strong flow of water. The cast iron collar and valve remained permanently attached to the main, leaving the flanged end ready to receive the new branch main. The entire operation was in every way successful, and required only one and a half hours.

The advantages of the new method are, of course, obvious. They include the avoidance of suspending the water supply, with its serious risks in case of fire, to say nothing of the danger of fracturing the main which attended the old-fashioned way of pumping the main dry at the point affected and cutting out a section with hammer and chisel. The process is far more expeditious, and is reported to be cheaper. For the above details we are indebted to Messrs. Clark W. Harrison and Co., of 72, Fenchurch Street, London, who are introducing the machine into this country. We understand that connections have been successfully made as large as 36 in. diameter to a 48 in. main, and against a pressure as high as 190 lb. to the square inch.



THE SMITH TAPPING MACHINE





ELEVATION AND UPPER DECK PLAN OF THE NEW JAPANESE PROTECTED CRUISERS "KASUGA" AND "NISSHIN" (FORMERLY "RIVADAVIA" AND "MORENO"), PURCHASED FROM ARGENTINA.

Japan's Latest Cruisers.

The armament comprises one quick-firing 10-in. gun placed in the forward barbette, on the *Kasuga*, and two 8-in. guns, similarly mounted on the *Nisshin*; two 8-in guns in the after barbette, and fourteen 6-in. rifles. The secondary battery includes ten 3-in. rapid-firing guns and four above-water torpedo tubes.

The Chloride Electrical Storage Company, Ltd., are now supplying their new negative known as the "Exide." This plate embodies several important improvements in design and detail. The firm are also sending out a new type of board separator, which takes the place of the glass rod separators formerly employed, and prevents any short circuiting from plate to plate.

The Borough Council of Battersea has lately placed with Messrs. Mather and Platt, Ltd., of Salford Iron Works, Manchester, an order for a second electrically-driven pump for drawing the necessary condensing water from the Thames and lifting it to the tank on the top of the engine-house. The pump is of Mather and Platt's high lift turbine type, No. 7 size, capable of delivering a maximum of 100,000 gallons of water per hour, which, however, may be reduced to half that amount when desired. The total head will vary 50 to 60 ft. according to the state of the tide in the river. The pump is driven by an entirely enclosed steel-clad motor of 60 b.h.p. taking current at a pressure of 460 to 520 volts. The contract includes all the piping and valves, both suction and delivery and the starting and regulating switches, and the whole plant is a duplicate of that supplied by the same firm and put down some time ago.

Among the electrical contracts recently secured by the British Westinghouse Electric and Manufacturing Company, Ltd., are the following: Twelve 50-kilowatt and six 18-kilowatt transformers for the South London Electric Supply Corporation; twelve 50-kilowatt transformers for Coventry Corporation; a contract for the supply of meters for twelve months for the Borough of Islington; and the supply of single and poly-phase meters for twelve months for Sydney Corporation.

A contract has been placed by the County Council of Lanark with Meldrum Brothers, Ltd., Manchester, for one of their 3-grate "Simplex" Refuse Destructors with suitable boiler plant, to be erected at Cambuslang.

Messrs. J. and J. Charlesworth, Colliery Proprietors, of Wakefield, have placed a large order for a complete coal screening plant, including the whole of the steel structural buildings, roofing, picking belts, tipplers, etc., having a capacity of 3,000 tons per day, with Messrs. Graham, Morton and Co., Ltd., this plant is for their Kilnhurst Pit, Rotherham.

Messrs. Graham, Morton and Co., Ltd., are also constructing nine bridges, to be erected between Boston and Grantham on the Great Northern Railway, and two bridges to be erected in London for the South-Eastern and Chatham Railway.

The British Westinghouse Electric and Manufacturing Company, Ltd., have just received an order from the Erith Urban District Council for a 500-kilowatt three-phase engine-type alternator to operate at 3,000 volts 50 cycles.

NEW TYPE OF FIRE BOAT BUILT FOR MESSRS. HUNTLEY AND PALMER.

A Novel Motor Floating Fire Engine.

The petrol motor is specially well adapted for driving fire extinguishing machinery, and Messrs. Merryweather and Sons have already made several land engines, which have proved very successful. This firm has now completed a new type of fire boat, the hull being of steel, 32 ft. long, 9 ft. 6 in. beam, with a draught of 2 ft. 6 in. It will pass under a bridge 4 ft. 6 in. from water level, and has been built for Messrs. Huntley and Palmer's biscuit works at Reading, where it will be kept on the canal ready for work in case of fire.

The boat has two four-cylinder petrol engines, each of 30 h.p., and each driving a Merryweather patent "Hatfield" three-barrel pump at high speed. Each pump delivers 300 gallons per minute, and they can be run together or independently. The boat is propelled by water jets, two forward and two aft, controlled by levers on deck.

The full power of the pumps can be used for propulsion, or turned into the outlets on deck, from which six hoses can be worked at once or the whole delivery turned into one stream, for directing which a special "monitor" is fitted.

The ignition is on the high tension system, with duplicate batteries and coils. Suction for the pumps can be taken on either side of the boat. Large exhaust boxes are fitted at each side, giving very quiet running. Two revolving reels aft carry 1,000 ft. of hose, and tanks are provided for petrol for 10 hours' running. The trial was very successful, a big jet being thrown over 150 ft. high, and six streams, each about 80 ft., were projected simultaneously.

Following on the five 400 kilowatt sets, which Messrs. Mather and Platt, Ltd., of Salford Iron Works, Manchester, have already supplied for the Belfast Electricity Works—four in 1899 and one in 1900—they have now received the order for a sixth set, also of 400 kilowatt capacity, generally similar to the one supplied in 1900, but embodying several new and improved features in the design of both dynamo and engine. The engine is one of Belliss and Morcom's self-lubricating three-crank three-cylinder triple expansion type, running at 330 revolutions per minute, and designed to work either condensing or non-condensing with steam at 160 lb. pressure and superheated 50° F. The dynamo is a six-pole machine, compound wound to give a normal output of 400 kilowatt at voltages from 440 volts to 550 volts, and will be capable of standing an overload of 25 per cent. The yoke ring and poles are of cast steel, split horizontally; the armature is of standard type, with a drum winding in a slotted core. The machine is carried upon an independent bedplate provided with flanges for bolting up to a similar bedplate carrying the engine.

For the Inca Gold Development Corporation of Peru, Ltd., an electrically-driven gold dredger is to be built by Messrs. Lobnitz and Co., Ltd., of Renfrew, under the direction of their expert, Mr. T. Ross Burt.

Messrs. Newton Brothers, electrical and mechanical engineers, have removed their offices from Full Street to 21, Market Place, Derby.

The Melting Pyrometer.

This instrument has been introduced by the Horsfall Destructor Company, Ltd., for the purpose of ascertaining, within reasonable limits, the temperature in furnaces and flues where pyrometers of the kind at present upon the market are not entirely suitable. It may be admitted at the outset that the most correct instrument for such purposes is the well-known electrical pyrometer, which gives accurate readings, but which is in itself a delicate and expensive instrument, and one not likely to be entrusted to the ordinary workman or labourer. The instrument which we now illustrate is intended for rough commercial approximation, and consists essentially in the provision of a series of metals and alloys, which melt at temperatures varying from about 300 deg. F. to about 2,000 deg. F. These metals and alloys are arranged in separate small receptacles, in a small and handy case.

The method of working the melting pyrometer is as follows:—The temperature of the furnace is roughly judged, and a series of, say, eight metals is then placed in a regular sequence in a holder contained in the case, the metal having the highest melting temperature being placed in the top compartment of the holder. A printed list of the metals, giving their temperatures in Fahrenheit and Centigrade is provided, having columns ruled for the different tests which it may be desired to carry out. A note of the series put into the furnace is made by simply putting a cross at the highest and lowest metal employed upon the printed list. The instrument may then be entrusted to a labourer to take away and hang in the furnace at the point required for two or three minutes, when it may be brought back for reading. It is then obvious that the temperature of the furnace lies between the ascertained temperature of the highest metal which is found to be melted, and the ascertained temperature of the lowest metal which is found to be unmelted. Any person practised in judging temperatures can no doubt manage with a series of even three or four melting temperatures, instead of eight, which is the maximum allowed for in the holder.

The instrument is the outcome of a great deal of patient investigation and experiment, the great difficulty being to obtain suitable alloys with well-defined melting-points giving the required sequence. It should be useful to the users of all kinds of kilns, furnaces, and destructors, gas managers, and engineers, who are engaged in making boiler tests.

NEW MELTING PYROMETER
(Watson, James and Bullock's patent).

BORINGS FOR WATER SUPPLY.

MESSRS. MATHER AND PLATT, LTD., have just completed the contract for sinking two boreholes at the pumping station of the Wallasey Urban District Council, Sea View Road, Liscard, Cheshire.

This work was rendered necessary owing to the water level having fallen to such an extent that the existing pumps in the deep well could no longer be worked at their normal speed and output of $2\frac{1}{2}$ million gallons per day.

The two boreholes are each 42 in. in diameter, and have been sunk from the bottom of the existing well, which is 12 ft. in diameter and 166 ft. deep, the one to a depth of 320 ft., and the other to a depth of 816 ft. from the surface. The working barrels of the pumps formerly placed at the bottom of the 12 ft. well have now been lowered down the boreholes to a depth of 250 ft. from the surface; and thus a sufficient supply of water is obtained for the pumps to work at their normal speed.

The borings have been successfully carried out in the face of exceptional difficulties, as owing to the confined space inside the pump house and the presence of the existing pumping machinery, it was impossible to use the ordinary pattern of boring plant; besides which one of the two pumps in the well had to be kept available for work at any minute in case of use.

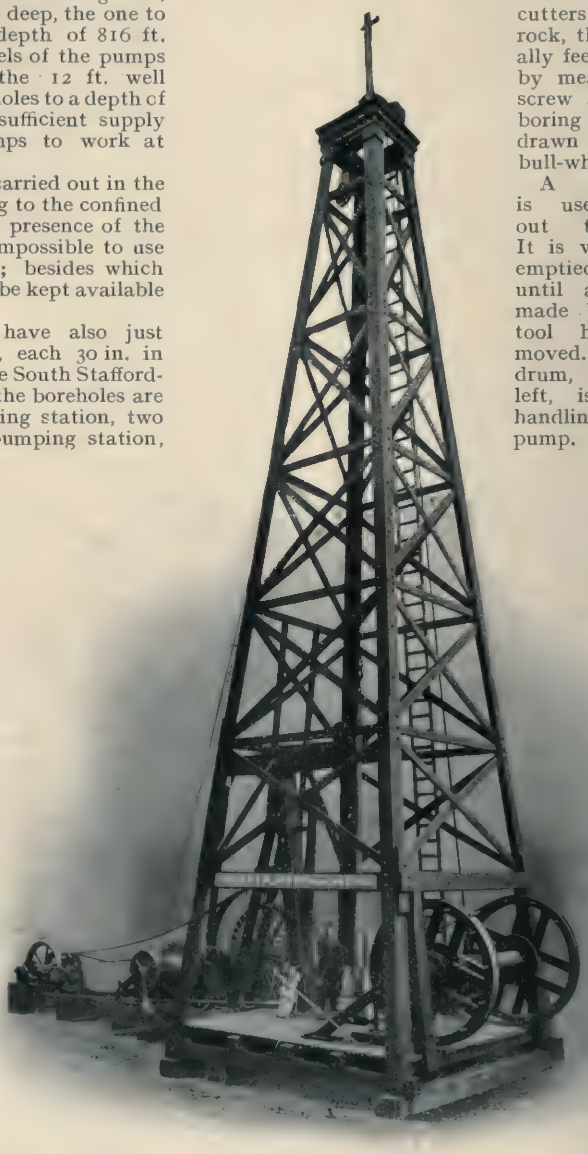
Messrs. Mather and Platt, Ltd., have also just received an order for five boreholes, each 30 in. in diameter and about 600 ft. deep, for the South Staffordshire Water Works Company, two of the boreholes are at the Lichfield (Trent Valley) pumping station, two at King Winsford for the Ashwood pumping station, and the fifth boring at a new station at Pipe Hill, near Lichfield.

Plenty of space will be available for the operations which are to be conducted for the South Staffordshire Waterworks Company, and consequently the ordinary round rope system will be employed. The improved form of apparatus is illustrated herewith, and is thus described :—

It consists of a timber erection or derrick about 60 ft. high, supporting a guide pulley at the top. On one side is arranged a hoisting barrel with bull-wheels, and on the other a walking beam. The latter is actuated by a connecting rod and crank, driven by a large belt-pulley from a steam engine. One end of the walking beam is connected by a round rope to a boring bar of great length and weight, the other end of the rope being coiled on the bull-wheel shaft or barrel, which is fitted with a brake. The crank arm has several holes for the reception of the pin, to permit of various lengths of stroke.

The elasticity or spring of the rope permits of a rapid rate of working. The bar hangs some distance from the bottom of the hole, the distance varying from 6 in. to 3 ft. according to the length and consequent stretch of the rope. When motion is given to the walking beam, the heavy boring bar rises and falls in the hole with a periodic motion. The suspended weight stretches the rope until the cutters touch the bottom, when the whole rapidly rebounds. The bar is rotated by the borer twisting the rope at the surface; and as the cutters penetrate the rock, the borer gradually feeds out the rope by means of a long screw and nut. The boring tools are withdrawn by aid of the bull-wheel and engine.

A sludge pump is used to clean out the borehole. It is withdrawn and emptied several times, until all the debris made by the boring tool has been removed. A winding drum, shown on the left, is provided for handling the sludge pump.



APPARATUS EMPLOYED FOR THE FIVE BOREHOLES SUNK FOR THE SOUTH STAFFORDSHIRE WATERWORKS COMPANY.

The Civil Engineers' Visit to Hadfield's Steel Foundry.

SIR WILLIAM WHITE, K.C.B., LL.D., on the 20th ult., paid a special visit to the East Hecla Works of the Hadfield's Steel Foundry Company, Ltd., in company with other distinguished visitors and the Yorkshire Section of Students of the Institute of Civil Engineers. The party from London were conveyed by special train, which set the visitors down in the works, where they were received by Mr. R. A. Hadfield, chairman and managing director, General the Right Hon. Sir W. Brackenbury, Colonel Sir H. Vincent, M.P., Mr. B. Freeborough, Mr. Alex. M. Jack, directors, and Mr. Dixon, secretary.

Amongst those also present were: Admiral H. J. May, C. B., General Wace, C.B., member of the Ordinance Committee; Colonel Hadden, C.B., Director of Artillery; Colonel Pease, of the Ordinance Committee; Mr. H. T. de la Bère, C.B., Director of Army Contracts; Colonel Holden, superintendent of the Royal Gun Factory, Woolwich; Lieutenant-Colonel J. de Manzanos, Military Attaché to the Spanish Embassy; Captain Diaz, Naval Attaché, Spanish Royal Naval Commission; Mr. R. Kaye Gray, President of the Institution of Electrical Engineers; Sir Edward Carbutt, past president of the Institution of Mechanical Engineers; Sir George Bruce, M.Inst.C.E., Professor W. C. Unwin, of the City and Guilds Central Institute; Professor Arnold and Professor Ripper, of University College, Sheffield; Major Wooley-Dod, Mr. A. F. Yarrow, M.Inst.C.E., Mr. J. A. MacDonald, chief engineer to the Midland Railway; and Mr. F. Wooley-Dod, of the Commission of Indian State Railways; Mr. W. McDermott (director of Messrs. Fraser and Chalmers), etc.

PROJECTILES, etc.

The centre of attraction on arrival at the works proved to be an assortment of Hadfield's improved steel projectiles of all types, as manufactured at the Hecla Works, from 12-pounders to 13·5 in., weighing 1,250 lb. each; including the latest type of armour-piercing shell. In the Machine Shop, a quantity of rock-breaking machinery was inspected; also a group of machined special steel castings and forgings for the River Tyne High Level Bridge (North Eastern Railway Co.) electric tramway-car wheels and axles, etc.

THE LUNCHEON.

At the luncheon, Mr. R. A. Hadfield (presiding) first proposed the usual loyal toast, and incidentally mentioned that His Majesty the King has been an honorary member of the Institute of Civil Engineers for thirty-six years, and is also a patron of it.

The Chairman then gave the toast of the "President of the Institute of Civil Engineers — Sir William White"—remarking that the Institute had over 8,000 members, and was the largest institution of technical and professional men in the world. Its respected president had much in common with Sheffield, which city had done its best to help him to construct those magnificent ships of war with which his name was associated throughout the world. The "price of Admiralty" as Kipling had said, was indeed heavy at times, and they had had the fact illustrated out in the East quite recently. It was such a man as Sir William White who had made Admiralty possible to England. Referring to the establishments of the firm, Mr. Hadfield said it would unfortunately not be practicable for the party to visit the old Hecla Works, which were 1½ to 2 miles distant, where they made their shot and shell. As regarded the East Hecla Works, where they were, the site of those works 5½ years ago was practically an unploughed field; to-day the works sent out products of all kinds for the engineering and mining and other industries, and the party would be able to inspect most of the departments in full work. He specially invited the attention of visitors to the mechanical testing of various kinds of steel and alloys, also to photographs showing the micro-structure of the metals, and to the various processes by which they sought to improve their products.

Sir William White, who had a very cordial reception, expressed the sense of obligation felt by himself and by the members of the Institute of Civil Engineers for the extreme kindness and warm hospitality shown them by the firm of Messrs. Hadfield. On behalf of the Institute, and particularly of the Yorkshire and Newcastle Associations of Students of the Institute, he desired to express most sincere acknowledgments. In coming there they were visiting works of which the country might well be proud. He had known them in their earlier form, but he had not until that day been able to come to see the new and extended works. He was intimately acquainted with the work which had been done by Mr. Hadfield now for many years in connection with the scientific development of the manufacture of steel, a most remarkable personal achievement, and he felt that the members of the Institute would desire him publicly to express the admiration which all engineers not merely in this country, but throughout the world felt for the researches that he had undertaken, and the wonderful and remarkable results that he had obtained. They would see during their visit a great

variety of examples of the circumstance that Mr. Hadfield in his own person united the manufacturer of steel and the user of steel; therefore, he knew by practical experience what users of steel required, and as a manufacturer he had provided every material in the form required most efficiently to fulfil the conditions of the special problems to be faced. But Mr. Hadfield was more than that; he was recognised by men of science throughout the world as a man deserving to be included in their own ranks. He did not wish to say too much in Mr. Hadfield's presence, but this he would say, that though Mr. Hadfield's candidature for the Royal Society was not successful this year, it was a candidature that, in his opinion, would succeed in the early future, so that metallurgical engineers would have the honour of including another of their number in the lists of that famous society in the person of Mr. Hadfield. The Council of the Institution of Civil Engineers had signalised their recognition of Mr. Hadfield's professional activity and merit by including his name in the list of candidates for membership of their body, and he (Sir William White) hoped that after the election a week from that date, Mr. Hadfield would be a member of the Council of the Institute of Civil Engineers. He had for years, in season and out of season, been pleading for the close association of practical manufacture in this country with scientific research. It was in that manner much more than by mere laboratory research that the advances which had been made in the past would be equalled or exceeded in the future. In Mr. Hadfield they had a pioneer in that direction; one who for many years, in the scant leisure of a busy professional life had devoted himself to scientific research of the highest order. Mr. Hadfield's productions in regard to the alloys of iron with manganese, chromium, nickel, and most lately, with tungsten, were works of the highest order, not merely to metallurgists, but to all who were interested in the development of the applications of chemistry in manufacture. What the visitors would see had been arrived at by no casual or accidental discoveries, but was the result of well-ordered and organised research. He trusted that the example which had been set here and elsewhere in this country would be very generally followed, and that the means which had produced the high-standing of German manufacturing and commercial knowledge at the present time would no longer be chiefly represented in that country, but that it should cease to be true that researches originated in this country, and carried to effect here on the scientific side, were, on the practical side, applied and developed abroad. In conclusion, Sir William White said he was asked to add to the expressions of thanks and indebtedness to the firm which he had already made, similar expressions on behalf of the eminent Spanish military officers who were present with them, also on behalf of the representatives of the War Office, and that patriarch of his own profession, Sir George Bruce. He proposed "Success to the firm of Hadfield and Company: long may it flourish." [Applause.]

A TOUR THROUGH THE WORKS.

Moulding in all stages occupied the attention of the visitors on the resumption of the inspection, after which an adjournment was made to the tramway and railway lay-out department—a large open space of about five acres, on which the ground is covered with timber baulks to form a flooring, whereon junctions, points, and crossings of electric tramway and railway lines are laid out in all their intricacy to suit the special positions for which they are being constructed. The most instructive feature of the afternoon and possibly the best appreciated was the firing of specimen capped and uncapped projectiles of Hadfield's make against a steel armour-plate, the effect of these capped projectiles, as described and illustrated in detail in PAGE'S MAGAZINE* being completely demonstrated. The projectiles known as the Heclon armour-piercing capped shells are $4\frac{1}{4}$ in. diameter, and weighing 31 lb. They can be fired from a Krupp gun capable of giving velocities up to 2,800 foot seconds (equal to a range of 17 miles), with a striking energy up to 1,686 foot tons, which would perforate $15\frac{1}{2}$ in. of wrought iron. The shells were actually fired at a 4 in. steel plate, with a velocity of 1,850 foot seconds, and a striking energy of 738 foot tons, capable of perforating $8\frac{3}{4}$ inches of wrought iron. The shots were fired electrically, the party meanwhile being sheltered in a heavily earthed and timbered enclosure. The uncapped projectile was badly smashed, while the projectile with the soft cap passed right through the target practically undamaged.

After the party had been photographed in a group, the Foundry Track Work Department, Machinery and Finishing Shop, Power Station, and the Annealing, Fettling, and Grinding shops were successively visited.

Visitors specially interested in the testing of materials then proceeded to the Testing Room, where the 100-ton Whitworth Testing Machine was working on tensile and compression tests on several of the numerous special grades of steel manufactured at East Hecla Works, including Hadfield's patent "Era" manganese steel, special mild steel for locomotive wheel centres, special high elastic limit steel, etc.; also drilling and other tests on this steel. An exhibition of research instruments, included permeability and hysteresis testing instruments, pyrometers for registering high temperatures.

The Smiths' Shop, Colliery Truck Building, Machine Shops, Pattern Shop, and Test Room also claimed attention.

Although the Company are primarily steel founders, forgings for all branches of engineering work are produced. The visitors had also an opportunity of inspecing ore-breakers, screening plants, elevators, and conveyors for ore and coal, etc., in process of construction.

The management has always made a point of providing special steel for different classes of work, according to the mechanical properties needed for the working conditions. These conditions are extremely various. This system of working has necessitated an extensive laboratory and scientific staff, both for chemical and physical tests. This is a special feature to which Mr. R. A. Hadfield has always given particular attention, and it has been responsible for the special grades of steel which have gained the firm a world-wide reputation. The most prominent and best known amongst engineers is the Hadfield's "Era" manganese steel, which is so hard that no steel tool will cut it, while, at the same time, it is so tough that pieces half an inch thick can be bent nearly double cold without cracking.

* "The Gun v. The Armour Plate," by John Leyland.—October 1902.

MONSIEUR DU BOUSQUET AND HIS WORK.

AN APPRECIATION.

BY CHARLES ROUS-MARTEN.

A Great French Engineer.

It has, I believe, been mentioned by me already in these "Notes" that there exists a curious controversy or dispute, or rivalry—none of these is the word I want, but the English language does not seem to supply the right one—touching the question to whom is due the chief credit for the now-famous de Glehn compound locomotives—M. de Glehn himself, or M. du Bousquet? The dispute consists not in the desire of M. de Glehn on the one hand, or M. du Bousquet on the other, to claim for himself the sole or even chief credit, but in the generous eagerness of each of these two distinguished engineers that an undue share of the credit shall *not* be awarded to himself, but that the fullest possible share shall be allotted to the other. A generous emulation of this sort is, perhaps, not commonly found in any profession; it is honourable in the highest degree to both gentlemen. But the circumstances of the introduction of the de Glehn system are specially creditable in another way to M. de Bousquet, the Chief Mechanical Engineer of the French Northern Railway. At the time it was first brought forward by M. de Glehn, M. du Bousquet, who had recently succeeded to his present position as head of the Locomotive, Coaching and Wagon Departments of the Chemin de Fer du Nord—his precise title being "Ingénieur-en-Chef du Matériel et de la Traction"—had himself devised a system of locomotive compounding which seemed to promise good results. Very few men indeed in his position could or would have resisted the temptation to introduce his own design, at any rate tentatively. But M. du Bousquet placed the interests of his company before all else, and, having convinced himself of the merits of the de Glehn method he first tested it thoroughly, and then definitely adopted it, with results which are of world-wide celebrity.

Du Bousquet *versus* de Glehn.

As most engineers are aware, it fell to my privilege to be the first to introduce the de Glehn compounds to the notice of this country. Until I happened to go to Paris, seven years ago, on a purely non-professional visit, I merely knew—as did others of my profession in this country—that there were such things as compound express locomotives on the French railways, but of their work or capacity I knew virtually nothing. Consequently, I went over with an entirely open mind. My initial run, Calais to Paris, in a train timed as fast as is any British train—with only two or three exceptions—for the same distance, with a load of 20 coaches, a compound engine, No. 2.158, made up something like 18 minutes, and climbed gradients of 1 in 125, 1 in 135, and 1 in 200, as I had never before seen them climbed with such a load, came as an absolute revelation to me. It set me at once upon a series of experiments which have continued ever since at intervals to this day. M. du Bousquet gave me most courteous and extensive assistance, including access to all information and the frequent use of a dynamometer-car and a staff of able assistants. The results, which I have published from time to time, were such as to prove conclusively that the de Glehn compounds which M. du Bousquet was procuring in large and increasing numbers, were doing work such as had never before been authentically recorded, at any rate on this side of the Atlantic. But several of the leading British engineers personally admitted to me that the figures were as complete a revelation to them as to myself. At a very early stage of my investigations M. du Bousquet urgently impressed upon me that the credit of the system of compounding which was employed must not be given to him, but was due to "Monsieur de Glehn, a compatriot of your own," as he put it. On the other hand, M. de Glehn was equally emphatic in impressing on me that while he was the inventor of the actual system of compounding, yet he could not have succeeded in introducing it had it not been for the hearty and self-sacrificing co-operation of M. du Bousquet, including that gentleman's large adoption of it in his highest class of express engines. Surely a most generous and honourable rivalry!

Developments.

In its original shape the standard du Bousquet de Glehn compound locomotive was an eight-wheeled engine having the driving and trailing wheels coupled with a leading four-wheeled bogie. Practically in this form the type found its way to every other main line in France—the Etat, Orleans, Midi, P.L.M., Est, and Ouest. Then came the ten-wheeled developments, first in the 4-6-0 shape, as No. 1301 on the Midi and No. 3.121 on the Nord—types which proved most valuable as passenger expresses as well as on fast goods duty—and then in the 4-6-0 or "Atlantic" type which, so far has proved the climax of the system. The twin pioneers of this class, Nos. 2.641 and 2.642 of the French Northern Railway, were specially designed by M. du Bousquet to utilise in its fullest potentiality the de Glehn method of compounding, by employing the principle in a new locomotive designed particularly for swift running combined with great power of load-hauling and hill-climbing. The new Great Western engine "La France" is in all essential points, as I have previously mentioned, a virtual counterpart of M. du Bousquet's Nos. 2.641 and 2.642 of the Paris 1900 Exhibition, to which have since been added Nos. 2.643-2.675. Of their achievements I have recorded in these columns many instances which came under my own personal observation. They have yet to be surpassed by any engine so far built. Nor is there any reason to doubt the ability of "La France" to do everything that her French sisters have done whenever she is afforded the opportunity of doing so. Meanwhile, her design has been reproduced in a far larger class on the Paris-Orleans line, and the other ten-wheeled type—the six-coupled class—has similarly been enlarged in the newest engines of the Orleans, P.L.M., Est, and Ouest French lines.

An "Engine of all Work."

It is rather remarkable that, whereas this 4-6-0 type was originally adopted by M. du Bousquet for use on fast-goods and heavy passenger-excursion traffic, its capacities have gradually so expanded and multiplied in practice that engines of this—the 3.121 class—are now habitually employed not merely on trains of these two orders, but also in hauling many fast expresses on the one hand and heavy coal trains on the other. Shortly after they began regular work, M. du Bousquet courteously allowed me to have one of them experimentally on the best Calais express, which then left Paris at 9 a.m., with the result that the engine performed the fast running in all respects satisfactorily, gaining several minutes on each stage, and arriving perfectly cool at Amiens. Since that date these engines, which now number 105, may often

be seen on some of the swiftest expresses, and they never seem to have any difficulty in not only keeping booked time, but also in making up time when late. In the other direction, moreover, these locomotives have superseded the eight-coupled non-compound class on many coal trains which run from Lens to Paris. M. du Bousquet himself states that these six-coupled engines with leading bogies and 5-ft. 9-in. coupled wheels, actually haul coal trains weighing 910 tons behind the tender, the entire distance of 143 miles, in *exactly half* the time taken by the eight-coupled non-compounds with 4-ft. 3-in. wheels, which latter took 14 hours as against the 7 hours occupied by M. du Bousquet's compounds. This represents a very remarkable economy.

M. du Bousquet's Suburban Engines.

In each of the last two years M. du Bousquet has introduced a fresh locomotive novelty. The earlier one was a very fine twelve-wheeled double-bogie tank-engine for extended suburban service and semi-express work. This type has been largely multiplied, and is in extensive and very successful use. Its twelve wheels are distributed in three separate groups. There is a four-wheeled bogie at each end, and the two middle pairs of wheels are coupled. I may deal with this type more fully on another occasion than space limits will permit to-day. The other novelty is a tandem compound tank engine for urban and closer suburban work—mainly for the Paris Ceinture Railway, which needs capacity for very quick starting. Hitherto this has not been adequately attained by non-compound locomotives, but M. du Bousquet's new tandem compound seems to have fulfilled the requirements of the case very satisfactorily, and hence to have met, in a large degree, the objections entertained by myself and others to the use of compounds for trains that have to make frequent stops. This engine has two 13-in. high-pressure cylinders placed behind two 21¼-in. low-pressure cylinders. By an ingenious device, it is contrived that the low-pressure valve shall be always a little later in its travel than the high-pressure valve which allows larger admission and smaller compression in the low-pressure cylinders than occurs in the ordinary system. The six-coupled wheels are 5 ft. 3 in. in diameter, and the piston stroke is 23½ in. in length. Fifteen of these skilfully designed and very efficient engines—which weigh 62 tons in working order—are now at work with highly favourable results.

M. du Bousquet on Locomotive Compounding.

Never, perhaps, have the true advantages of locomotive compounding been set forth with more succinct lucidity than by M. du Bousquet in a letter which M. Sauvage has published in the very able and interesting paper that he read recently to the Institute of Mechanical Engineers. After stating that the original experimental compound which had been working on the Nord line for eighteen years, had shown an average saving of 6·39 lb. of coal per mile as compared with the ordinary locomotives, and expressing the opinion that the saving is mainly due to the reduced condensation in the cylinders, which accrues under the compound system, while the very slight increase in oil consumption and repairs are comparatively inappreciable, M. du Bousquet goes on to say: "The economy of coal for our company, which gets cheap coal on its lines, may appear of secondary importance. But it must be observed, and that is of chief importance, that the economy is obtained only during a fraction of the total run. For instance, an ordinary goods engine running down grade with steam shut off, does not consume more than the compound in the same circumstances. In fact, the saving is obtained on the level parts and chiefly on rising gradients. The mileage corresponding to the saving is much below the total mileage. This saving for each kilometer of level or rising line is far superior to the average. . . . Important results are thus obtained; the daily mileage of locomotives, drivers, firemen, train staff, is greater; carriages and wagons are better utilised; piloting and supplementary trains are dispensed with." This puts the case in a nutshell so far as that chase is concerned, just as M. de Glehn did when he pointed out that compounding enabled far smaller and lighter locomotives to do the same work that was performed by larger and heavier engines. And the practical results, tested by lengthened experience, do certainly appear conclusively to support these views.

Locomotive Compounding in Britain.

The London and North Western has now been removed from the list of railways that build compound express engines. Mr. George Whale, the new Chief Mechanical Engineer of the premier British railway, has just brought out a fresh type of express locomotive, which, unlike all the express engines which have, nominally, at any rate, been constructed since 1882, that is to say, during the past twenty-two years, is of the non-compound order. Mr. Whale's engine, which is numbered 513, and suggestively named "Precursor," is in many respects an enlargement of the very efficient non-compound express type in the "Precedent" class, which Mr. Webb developed from his predecessor's "Newton" class of 1866, and into which he subsequently converted all the "Newton" set of 96 in number. Those added to the 70 built originally by Mr. Webb himself made a total of 166 locomotives all similar, and to these may be added 90 more, which virtually differ only in having coupled wheels 6 in. smaller in diameter. Latterly, Mr. Webb fitted 3-in. tyres to the 6 ft. 6 in. coupled wheels, thus enlarging their diameter to 6 ft. 9 in. This latter size has been adhered to by Mr. Whale, who, however, has brought his engine up to date by providing far larger boilers and cylinders than any previously in use on the London and North Western. The boiler, which is 11 ft. 9⅝ in. long and 5 ft. 2 in. in diameter outside, with a firebox 7 ft. 4 in. in length, yields 2,009 square feet of total heating surface, 161 square feet being in the firebox, which has a grate area of 22·4 square feet. The cylinders placed inside are 19 in. in diameter, or 1 in. more than any non-compound cylinders previously used on the London and North Western. The piston stroke, too, is lengthened from 24 in.—the standard London and North Western length hitherto from time immemorial—to 26 in., the normal modern length of stroke. In respect of steam pressure, Mr. Whale has preferred to make a change in the opposite direction. Mr. Webb had adopted 200 lb. in all his later engines, but this did not always prove satisfactory, and a reduction to 175 lb.—which pressure Mr. Webb was the first English engineer to employ, in 1884—was made in several instances, at all events. Mr. Whale sticks to 175 lb. He retains, however, the "double radial truck"—which his predecessor introduced, and never permitted without protest to be called a bogie—under the leading end of his new engine, contending, as did Mr. Webb in one of his last letters to me, that this plan permits an easier passing of curves than can be secured with the ordinary pivoted bogie. No. 513 "Precursor" is a very handsome locomotive, and, I hear, is already doing good work.

PAGE'S MAGAZINE

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OUR MONTHLY SUMMARY.

LONDON, April 22nd, 1904.

Forthcoming Imperial Exhibition.

In May, next year, an Imperial Exhibition will be opened at the Crystal Palace, in which all the governments and administrations of the British Empire will be asked to participate. The object of the exhibition is to "demonstrate that the British Empire produces all the necessaries and luxuries of life in quantities large enough to supply the wants of all its inhabitants, while their quality is at least equal to those produced in any other portion of the globe." In a word, it is intended to prove that the Empire "can be entirely self-sustained, and that in this respect it differs from any other, however large may be its area and varied its resources."

Electrification of Tyneside Lines.

The friendly competition between the North-Eastern and the Lancashire and Yorkshire Railway to be the first to complete the electrification of a standard railway ended practically in a dead-heat. The first electrical train on the newly electrified Tyneside lines of the former company was started by Lord Ridley, and completed the run to Benton and back easily within the scheduled time. At the ensuing luncheon, the British Thomson Houston Company were heartily congratulated upon the successful execution of the work. The average speed of the stopping trains on these lines will be about 22 miles per hour, but between Newcastle and Tynemouth quick trains will be run through without intermediate stops, performing the journey of about eight miles in 15 minutes. The goods traffic will continue to be dealt with, as at present, by steam locomotives, except on the short Quayside branch, on which electrical locomotives of an exceptionally powerful type will be employed. At present, however, only the section from Newcastle to Benton is running electrically, the journey occupying eleven minutes.

The Recovery of Submarine A1.

As we go to press, it is with melancholy interest that we are able to record the end of the long struggle involved in the raising of the unfortunate submarine *A* 1. The efforts made to recover the submerged boat have been probably little short of superhuman, and the grit and determination with which it has been accomplished in the face of enormous difficulties should serve to disarm the most unreasonable of critics.

On the subject of the unfortunate submarine, several interesting Parliamentary questions have been asked and answered. Mr. Yerburgh asked whether submarine vessels belonging to His Majesty's Fleet were so fitted that they might be easily grappled and raised in the event of their being so injured that the crew were unable to bring their vessel to the surface, whether *A* 1 Submarine could have been raised to the surface within forty-eight hours in the event of her crew having survived the shock of collision, and whether His Majesty's Fleet possessed any special salvage vessels or apparatus for the speedy recovery of vessels sunk in a harbour fairway during war time, or whether

they were entirely dependent upon private firms for such work. Mr. Pretyman's reply is that no special means are provided; these vessels are easily grappled owing to their shape. In the case of the *A* 1, no difficulty was experienced in passing hawsers under the vessel and attaching to lighters, and this was done by the dockyard; but, through the sand of the sea the hawsers parted, and the Commander-in-Chief then reported that there was no alternative but regular salvage operations. With regard to the second part of the question, it is impossible to say; the crew of the *A* 1 were probably drowned at once. The Admiralty have no special salvage vessels, and are dependent on private firms for such work. At each dockyard port, however, there are very experienced divers and a number of craft that could be utilised for raising vessels.

Mr. Gibson Bowles wished to know whether the Admiralty were aware that there were in existence British salvage companies of great experience and proved ability, and could he explain why none of these companies was called upon to undertake the raising of the sunken submarine *A* 1, and why the work was committed to the Swedish Neptune Salvage Company of Stockholm without any opportunity being afforded to any British company to undertake it. In reply to this, Mr. Pretyman states that the Admiralty is aware of the existence of qualified British salvage companies, and has already made use of their services. But the Neptune Salvage Company were successful in raising H.M.S. *Howe* in 1893, and, having one of their ships (the *Belos*) at Portsmouth at the time of the recent accident, their offer was accepted by the Commander-in-Chief, so as not to lose valuable time.

Technical Education in England, America, and Germany.

In the course of a general comparison between technical education in England on the one hand, and Germany and America on the other, Mr. R. Blair expresses the opinion that our evening schools on which we rely for technical instruction, are without parallel anywhere, but he points out that these are mainly training schools for operatives, for the 'hands' rather than for the 'heads.' We have nothing at present equal to the German 'Charlottenburgs' or American 'institutes of technology' for the industrial training of the 'heads,' the future captains of industry. In America such institutions as Sibley College (Cornell University) and the Massachusetts Institutes of Technology are already known throughout the United States and in Europe as institutions of the first rank for the training of 'heads' of industry. Between these and evening schools come others, splendidly equipped and lavishly financed, such as the Pratt Institute, Brooklyn (New York), the Drexel Institute at Philadelphia, or the Lewis Institute at Chicago, which train the 'petty officers,' men to hold intermediate positions between the heads of industries and the skilled mechanics. It is clear that, although in London, Manchester, and elsewhere we have institutions quite as well equipped and capable of giving as good a training as those of America, we have much to learn in the organisation and diffusion of our technical instruction.

Utility of the Mosely Report.

It must not be overlooked that the conditions which obtain here and in the United States are fundamentally different. But, while we cannot change the conditions it is nevertheless possible to carefully review the concentrated information which Mr. Mosely's Commission has rendered available, and apply to our own methods features judged worthy of emulation in connection with such points as their freedom from competitive examination, the obligatory participation of technical instructors in practical work, the need at home for increased encouragement on the part of the employers, etc. These and many other useful subjects for reflection will present themselves to readers of the Commission's report which is a volume of some four hundred pages, and can be obtained by anyone for 1s. Moreover, Mr. Mosely, following up the liberality which organised and financed the Commission, has arranged that any educational authority or member thereof in the British Isles, or any county councillor, local manager, headmaster, headmistress, or registered teacher shall obtain copies free on remitting to the publishers the cost of postage. Not only technical men, but all who are interested in education generally can scarcely fail to appreciate very highly the public spirit which Mr. Mosely has displayed and the well-timed service which he has rendered to the cause of educational progress.

Admiral Makaroff.

Russia, by the death of Admiral Makaroff, has lost not only her most able naval commander, but a distinguished scientist and inventor. In 1885 he made a cruise round the world as commander of the frigate *Prince Pojarsky*, and conducted important hydrographic researches which received the award of a prize from the St. Petersburg Academy of Sciences. As Chief Inspector of Artillery—a post which he occupied between 1891 and 1898—Admiral Makaroff designed and introduced several improvements in quick-firing guns. During the construction of the famous ice-breaker *Ermak*, which was built for the Russian Government by Messrs. Armstrong, Whitworth and Co., to his designs, he visited England, and succeeded in making many friends, being especially popular among the workmen.

The Electrical Engineers' Secretaryship.

We are pleased to have an opportunity of congratulating Mr. George C. Lloyd upon his appointment as Secretary of the Institute of Electrical Engineers, for we have more than once had occasion to appreciate his courtesy and tact as Assistant to the Iron and Steel Institute. These qualities contribute largely to the making of a successful secretary, but for the important duties he will be called upon to undertake many others are required, including technical knowledge, and the mastery of detail. Mr. Lloyd gained his education both in this country and in Germany. Upon completing a five years' apprenticeship with Messrs. Robert Stephenson and Company, marine and locomotive engineers of Newcastle-on-Tyne, he went to sea, and was for some years engaged as a marine engineer on English steamers trading with Brazil and the River Plate, and as engineer in Spanish ships trading with the West Indies. On his marriage, however, Mr. Lloyd wisely abandoned the sea, and took up engineering work in London. For a time he also travelled on the Continent as representative of Messrs. Mirrlees-Watson and Co., Limited, of Glasgow, and, prior to his appointment as Assistant to Mr. Bennett H. Brough, Secretary of the Iron and Steel Institute, he was engaged as assistant engineer to the firm of Messrs. Jeremiah Head and Son, of Westminster. As might be expected, he is a good linguist. The post of Assistant Secretary will be filled by Mr. Percy F. Rowell, who was chief assistant to the late Mr. W. G. McMillan.

The British Inventor and his Grievances.

Mr. W. Friese-Greene was one of the first to send in his views on the above question to the *Journal of the Society of Arts*, in response to the complaint raised in that publication by an inventor. He pleads for justice and common-sense in our patent laws, and that it may be made possible not only for a rich inventor to protect himself, but also that a poor inventor may be encouraged to patent his ideas with a certainty that he will obtain a proper return for any good invention he may make, and full protection of his rights without danger of being financially ruined by his own inventive genius and his attempt to contribute something to the welfare of his country. Mr. Friese-Greene's suggestions for the improvement of the patent laws are as follows :—

1. That a thorough search be made by the British Patent Office before the patent is granted.

2. That the cost of this search should be included in the initial fee.

3. That when a patent is once issued by the English Patent Office the presumption is not that it is bad, but that it is good, and that this presumption be one that the British courts are instructed to recognise in any action for infringement.

4. That the penalty for infringement (where the infringement is clearly proved) be not merely an injunction against further infringement and the actual damages proved (which latter are almost impossible of proof in many cases), but should be substantial and exemplary damages, which shall be sufficiently large to discourage others from attempting to infringe what they know to be a valid British patent. In other words, says Mr. Friese-Greene, "make the punishment fit the crime" which is not the case under the present law. In fact, it not infrequently happens that an inventor may win his action for infringeme n and be ruined by the delay and expenses he has to ncur over and above his damages and taxed costs.

5. Any man stating in his application that he is the original inventor, when it is proved he knows he is not, should be held to be guilty of perjury and should be prosecuted by the Public Prosecutor at the public expense.

6. Make one fee cover the entire cost of the invention for the full term. Anyone can figure out for himself what it means to maintain 25 or 30 British patents, many of which, while they are the basis of very valuable inventions, may be premature, in that certain features of the invention are not yet perfected, or the trade not yet sufficiently advanced to appreciate its value.

7. The appointment of a Royal Commission consisting of practical men who shall take evidence on the whole subject and report their recommendations to Parliament.

The Tramways and Light Railways Association.

At the annual dinner of the Tramways and Light Railways' Association, Mr. Alfred Baker presided over an attendance of one hundred and twenty. Mr. G. G. Gomme, in proposing the toast of the evening—"The Tramways and Light Railways' Association"—said that the Association had, at all events, solved one very difficult problem. He (Mr. Gomme) could remember the time when light railways were scarcely looked upon as kindred associations to tramways, and he was delighted to find that now they were considered as twins, and the fact that they were now united together in one Association, seemed to him a happy augury for the future. They, in London, were face to face with many difficulties, and they could not help feeling that an Association of this kind would help them to meet many of those difficulties—he meant, the difficulties of overcoming space, which could only be done by tramways and light railways. Mr. Atherley Jones, K.C., M.P., responded. After congratulating the members on the accession to office of Mr. Baker as President, he remarked that the object of the Association was to develop, as far as possible, by co-operation with kindred associations, and by legislative action, the interests of the public in the promotion of cheap and facile locomotion. He did not know that it had done very much towards the attainment of that result, but that had not been through any want of effort on the part of the Association, but through the innate conservatism that was the characteristic of English people. No one could deny that the present system of locomotion in this country was in a chaotic condition, and they believed that those difficulties could be best removed by those representing the various interests meeting together for the purpose of seeing where friction existed, and how it could best be removed. He believed there were representatives of railways there that evening, and he knew that not so very long ago the railways regarded tramways and light railways as dangerous rivals and as competing bodies. He did not believe that was the right view, but that tramways and light railways performed a work which was auxiliary and contributary to the advancement of railway communication in this country. In the same way, he believed that even the proprietors of omnibuses might be induced to regard the transition of a tramway over Westminster Bridge as not necessarily destructive to the British Constitution. An Association like that which had been able to enlist the co-operation and the sincere and active interest of men like Mr. Baker and others who were present was undoubtedly doing something and would hereafter do more to develop, in the interests of the public, the increased locomotion between various centres of population and also between what they might term the rural suburbs of great cities and the centres of those cities. By that means they would be doing something to solve the problem of the great glut of population in certain districts. The Chairman, during the evening, referred to the fact that he had just had placed in his hands a *souvenir* of the opening of the first tramway laid in London. It was in 1861, and was called the Marble Arch Railway. The guests invited on the occasion by the late lamented Mr. G. Francis Train, numbered several hundreds.

Labour Returns for March.

The Board of Trade labour returns for March show that there was a slight improvement as compared with the preceding month, due in some measure to seasonable causes. There was some improvement in employment for coal miners, and in the iron-mining industry it continues good. In the pig-iron industry employment improved slightly during March, but is still below the level of a year ago ; while in the iron and steel manufacture employment showed an improvement as compared with a month ago, and is about the same as a year ago. Employment in the shipbuilding trades continued to improve slightly during the month. It is, however, still bad, and worse than a year ago. The percentage of unemployed trade union members at the end of March was 11·8, as compared with 12·6 in February and 9·8 in March, 1903.

NAVAL NOTES.

BY

N. I. D.

GREAT BRITAIN.

SINCE my last instalment of notes, dealing with naval matters the estimates for the year 1904-05 have been published. They amount to £36,889,000, which is more by nearly a million and a half than the sum voted last year. Nearly half this latter sum, however, is required to complete the purchase of the new battleships *Triumph* and *Swiftsure*, and thus the actual increase is not so large as it appears at first sight. The new construction proposed for this year is made up of two battleships of a new type to be called the *Lord Nelson* class, four armoured cruisers of the *Duke of Edinburgh* class, fourteen destroyers, and ten submarines. The battleships will be built by contract, and will be laid down in the autumn.

Next to the publication of the Estimates, perhaps the most important event has been the completion and commissioning of the *Queen* and *Prince of Wales* battleships. The *Prince of Wales* relieves the *Exmouth* in the Mediterranean, in which fleet the *Queen* relieves the *Russell*. Another important commissioning is that of the *Cornwallis* on February 9th for the Mediterranean.

The trials of the *Triumph* and *Swiftsure* have now been carried out, with extremely satisfactory results in both instances. Both vessels succeeded in developing more than the anticipated horse-power, and the speeds attained were 20·17 and 20·5 knots by the *Triumph* and *Swiftsure*, respectively; the i.h.p. in each case was rather more than 14,000, and the coal consumption was 1·73 lb. per unit of power per hour. It is of importance, however, to note that these vessels only underwent six hours full power trials, whereas all other vessels for the Royal Navy undergo eight hours.

Launches have not been very numerous in the armoured cruiser class during the last two months, the *Argyll*, which was launched on March 3rd, by the Greenock Foundry Company being the only one of importance. The *Devonshire* will leave the slips at Chatham before these lines appear, and with her the last of the County cruisers will be in the water.

A change in the armament of the later vessels of the *Duke of Edinburgh* class is to be undertaken. The change will involve structural alterations. The secondary armament of ten 6-in. guns is to be replaced by four 7·5-in. guns. These guns will be placed on the upper deck instead of on the main deck, as the original pieces were. The advantages gained by such a change are obvious, and the reduction in the number of guns is a small disadvantage compared with the increase in weight and command. Changes are also taking place in the *Devonshire* class, where the four forward 6-in. guns will be replaced by two 7·5-in. guns, in gun houses, on the upper deck, again with an increased command and consequently more effective long range fire.

The *Essex* has been put into commission, as has also the *Lancaster*, the latter on March 22nd, and the former on February 5th. There are now seven vessels of the earlier County class in commission, and the *Cornwall*, *Suffolk*, and *Cumberland* should also hoist the pennant before the autumn. The *Cornwall's* trials have been completed with very satisfactory results, the vessel attaining a speed of twenty-four knots on her eight hours full-power trial.

Among smaller craft, there is the launch of the *Sapphire*, third-class cruiser, to chronicle on March 17th, at Palmer's Yard, Jarrow. The *Sapphire* is the last of four vessels named after gems, two more of which were projected in last year's programme, but were ultimately abandoned. The launch of the *Sapphire* took place three months after the first keel plate was laid.

The first of the new "scouts," the *Sentinel*, has been launched by Messrs. Vickers, Sons, and Maxim. The ceremony was performed by Miss Hay, daughter of one of the directors of the company, on April 19th. The *Sentinel* is 360 ft. in length, with 40 ft. beam, and 2,920 tons displacement. Her estimated horse-power is 17,000, and the maximum speed is to be 25 knots, steam being supplied by twelve boilers.

FRANCE.

The launch of the armoured cruiser *Victor Hugo*, at Lorient, on March 30th, has made it at last possible for work to be commenced on the *Jules Michelet*. The *Victor Hugo* was on the stocks thirteen months, some delay in her construction having been occasioned by the transfer to Lorient of building material from the dockyard at Toulon where it was originally intended she should be built.

The *Gloire*, armoured cruiser, has completed her trials. On her full power trial the horse-power developed by her engines was 14,400 giving a speed of 21·5 knots. The coal consumption worked out at 1·96 lb. per i.h.p. per hour. Her sister ship, the *Condé*, on trial attained a speed of 19 knots.

The *Leon Gambetta*, while on a steam trial, struck an unknown pinnacle of rock off the Black Rock Islands, near Brest. The damage done appears to be considerable, and it will be some months before the repairs can be completed.

Some interesting details about the new French torpedo-boats have been made public. The class is numbered 278-292, and the vessels are 121·4 ft. in length. They displace 90·6 tons, and, with engines designed to develop 1,900 h.p., are expected to make 26 knots speed. No. 279, which is already complete, made on her trials 26·55 knots. Two others of different design have just been launched—No. 293 at the Normand Yard, Havre; and No. 294 at Bordeaux. No. 293 is 129 ft. in length, displaces 97 tons, and is fitted with Parsons's turbine engines. Three turbines will be used when she is going at full speed (24 knots); one will be used for cruising speeds, and one for going astern. Her boilers will be Normand water-tube. No. 294 will be 126 ft. long, and fitted with turbines of Bréguet design. Her speed will also be 24 knots.

Two submarines are known to have been launched recently, the *Bonite*, at Toulon, on February 6th, and the *Aigrette* at the same port on February 23rd. This latter vessel of 172 tons displacement is one of thirteen which were to have been begun in 1902, but on two only of which work has been commenced.

GERMANY.

A scheme for further naval expansion is brewing in Germany beyond a doubt, and a new Navy Act may very shortly be introduced to the Reichstag. But for the present there is little to report beyond the launch of the small cruiser *Lübeck*, built at the Vulcan Yard, Stettin, and formerly known as the *Ersatz Mercur*. This vessel is chiefly notable for being one of the first German vessels to be fitted with turbines.

The programme for the completion of the battleships of the *Braunschweig* class puts the date of commissioning of the first two, the *Braunschweig* and *Elsass*, in August and October next, respectively. Of cruisers, it is hoped to have the *Hamburg*, *Bremen*,

and *Berlin*, all in commission. The new torpedo-boats *S*120-125, are expected to complete their trials during the year.

There are several vessels which it is hoped will be launched during the year, and two small cruisers, one at Bremen and one at Stettin, will take the water early in 1905. In the meantime, the armoured cruiser *Prinz Friedrich Karl* has commenced her trials at Wilhelmshaven. Her first full-speed trial gave very satisfactory results, the contract i.h.p. 17,000 having been easily developed, giving the vessel a speed of 21 knots. The *Elsass* will shortly commence her trials.

RUSSIA.

The new battleship *Imperator Alexander III.* has been under trial, with apparently satisfactory results. The engines, designed by Engineer Tenson, making on an average 114 revolutions under 250 lb. pressure of steam developed, 15,800 h.p. giving a speed of 17·36 knots. The coal consumption worked out approximately at 2·5 lb.

The Russian naval estimates for 1904 total 113,622,426 roubles, nearly three million roubles less than the sum actually expended during 1903. For shipbuilding and repairs the sum of 38,743,446 roubles is appropriated. No particulars of new vessels have, however, been made public, and the only ones which are reported to have been laid down are two protected cruisers in the Black Sea.

It cannot be out of place here to add a word about the catastrophe which occurred at Port Arthur on April 13th. The blowing up of the *Petropavlovsk*, with Vice-Admiral Makaroff on board, is one of those disasters at which all the world, belligerents as well as neutrals, stands aghast. The mines on which the ill-fated vessel struck appear to have been laid during the night by a Japanese mining vessel (Commander Oda) protected by two torpedo flotillas. Although the searchlights from the port were playing on her the whole time, the work she was doing does not appear to have been suspected by the Russians. At dawn on the 13th, two torpedo actions took place, and, as a consequence, one Russian destroyer, the *Beztrashni*, was sunk. At about 8 a.m., Admiral Makaroff, with all his available ships, set out in pursuit of the Japanese third squadron, consisting of the protected cruisers *Chitose*, *Yoshino*, *Kasagi*, and *Takasago*, under the command of Rear-Admiral Dewa. This squadron, by gradually retiring drew the Russian fleet further and further from its port. Admiral Togo, when informed by wireless telegraphy, of the success of his junior's ruse, made a dash for the harbour entrance. Vice-Admiral Makaroff appears, however, to have discovered the trap and made for port. On the way the *Petropavlovsk* encountered the mines, which sent her to the bottom, and the *Pobieda* was also reported to have been damaged. The Russian fleet in the Far East is now a negligible factor. Admiral Alexeieff is reported to have received stringent orders to keep his ships in the harbour until Vice-Admiral Skrydloff, who succeeds Makaroff, arrives. But before then Togo is almost certain to have made another, and very possibly successful effort to close the entrance to the harbour.

The Russians are shortly to have some submarines at Port Arthur, one having been already dispatched in sections, and the other being nearly completed.

UNITED STATES.

The Naval Appropriation Bill, which was accepted by the Senate on February 11th, includes, as new construction, one battleship of 16,000 tons, two armoured cruisers, of 14,500 tons; and three scouts, of 3,750 tons. These scouts it is reported are to have a speed of 24 knots and will have a radius of action of 5,000 miles. The protection will be slight and the guns of 3·9-in. calibre. The total amount authorised is $96,338,038, of which $29,885,000 will be devoted to the new programme.

The hull contracts for both the *Idaho* and *Mississippi* have been awarded to the Cramp Company of Philadelphia. Each is estimated at £600,000.

The *Virginia*, battleship, was launched on April 5th from the yards of the Newport News Company. The battleship *Rhode Island* and the armoured cruiser *California* should also be in the water before these lines appear.

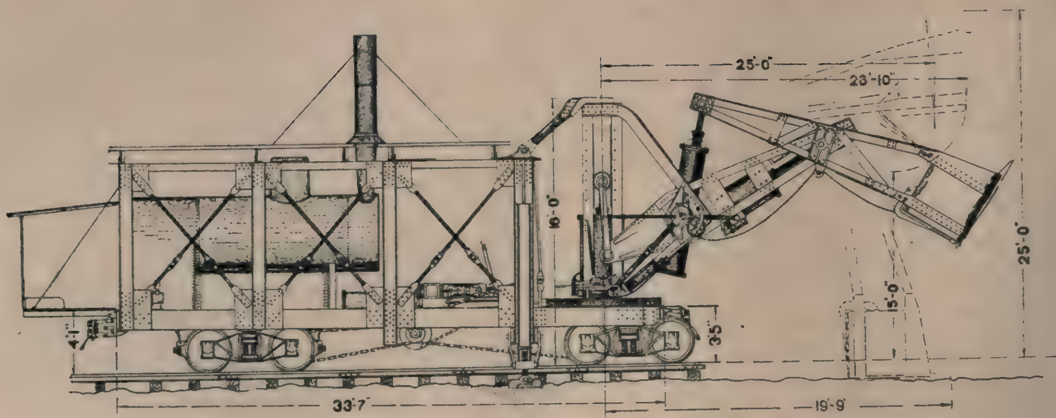
Progress on the vessels in hand at the various yards is favourably reported on.

JAPAN.

The most interesting item of news concerning the Japanese Navy is the description which has been made public of the new battleship design. One vessel of this class is building at Elswick, and another at Barrow. These vessels are to be completed in twenty-nine months. The principal dimensions are: length, 455 ft.; breadth, 78 ft. 2 in.; draught, 26 ft. 7½ in. The displacement is 16,400 tons, and the speed at least 18¼ knots. The horse-power, curiously enough, is not mentioned. The boilers, twenty in number, will be of the Niclausse type disposed in three boiler rooms, and will be built, with the main propelling machinery, by Messrs. Humphreys, Tennant and Co. The armament will consist of four 12-in. guns, mounted in pairs in barbettes, fore and aft; four 10-in. guns mounted singly in barbettes; twelve 6-in. guns disposed six on each broadside, five in the citadel and one on the upper deck; twelve 12-pounders and three 3-pounders. In addition, there will be five torpedo-tubes, four of them of the ordinary Armstrong-Whitworth 18-in. type and one on the line of keel astern, of a special design.

With regard to the armour protection there seems to be a tendency to revert to the box battery arrangement of the early seventies of the last century. The armour amidships is carried from below the water-lines right up to the upper deck. The main armour belt has a maximum thickness of 9 in., and extends from 5 ft. below to 2 ft. 6 in. above the water-line, and immediately above this again is a belt of 6-in. armour, extending from the after, 12-in. barbette, forward to the stem. Above this again is the 6-in. citadel armour, carried to the height of the upper deck, and enclosing both 12-in. barbettes. The barbette armour of the 12-in. guns is 9 in. thick on the exposed portions and 5 in. where the citadel encloses them. The 10-in. barbettes have 6-in. armour while the conning tower has 9 in., and the observer tower 5 in. of protection. In addition to these shelters for the officers there are three others, protected by 3-in. armour one above the conning tower, and one on each side of it. The protective deck which runs throughout the entire length of the vessel protecting the machinery, magazines, etc., is 2 in. thick on the flat portions amidships and 3 in. on the sloping sides which are carried down to meet the bottom of the main armour belt.

It is reported, and with some show of authority, that the Japanese have bought two submarines of Holland design, and that these vessels are now on passage to Yokohama.



KILGORE $2\frac{1}{2}$-YARD STEAM RAILWAY SHOVEL.

THE CIVIL ENGINEER AT WORK.

By C. H.

New Direct-Acting Steam Shove.

The new direct-acting steam shovel, illustrated herewith, has received a good deal of notice across the Atlantic. All movements of the dipper are controlled by four direct-acting steam cylinders having light-balanced valves operated by two easy-moving hand levers. The engineer's platform swings with the dipper. He has thus an unobstructed view at all times, and can dump the load when and where desired by means of a steam cylinder operated by a foot lever.

Economy in steam consumption is claimed for this appliance, and one man does the work ordinarily done by engineer and cranesman as the engineer both fills and dumps his dipper by steam. All motions of the dipper can be reversed with equal power. It can actually be shaken violently to toss off the sod or any large boulders too big to pass through the dipper opening, or to clear itself of sticky clay. By working two pistons at once the dipper can be moved in a direct line to the point desired. The dipper can dig in all kinds of materials, nose around a root or rock, reach beyond it to pull it back, pick it up, move in a direct line to the dumping point, and toss it out over the top of the dipper if necessary. The shovel is self-propelling, and can be transported to and operated in places where large shovels cannot be used. It is being introduced by the Kilgore Machine Company, of Minneapolis, Minn.

New Lighthouse at Dungeness.

The old lighthouse, built 114 years ago at Dungeness has been replaced by a new light which has just been brought into use after two years' hard work. The new lighthouse is circular in shape, and 140 ft. high from base to top of the lantern. It stands 40 yards inland from the old lighthouse. In addition to the high lighthouse, a low light, 40 ft. high, has been erected close to the shoreline over a powerful foghorn. The main high light gives flashes every ten seconds. It is a white flash, lasting ·88 second, with an intensity of 144,000 candle power. A subsidiary light, visible 13 miles, is exhibited from the same tower, showing red and green sectors. The focal plane of the main light is 130 ft. above high-water mark. The luminant used in the lantern is oil gas, burnt on the incandescent principle, the oil being vaporised. The old lighthouse is to be immediately demolished, except the base, which is being extended for residential and other purposes in connection with lighthouse work. The new light at Dungeness will be visible for $17\frac{1}{2}$ miles.

THE SHOVEL AT WORK.
The Steam Shovel handling broken rock in the quarry of the Kettle River Quarries Company, at Sandstone, Minn.

Widening London Bridge.

Since the last issue of this magazine went to press, the widened footways of London Bridge have been formally opened by the Lord Mayor. The work was begun in 1902, the roadway at that time being 34 ft. 6 in. in width, and the two footways 9 ft. 6 in. each, a total of 53 ft. 6 in. between parapets. After the widening, the roadway is 35 ft., and the two footways 15 ft. each, the total width between parapets now being 65 ft. The approximate amount of old granite removed for the recent widening was 55,000 cubic feet, the amount of new granite fixed being about 51,000 ft. The widening is carried on 325 granite-corbels fixed on each side of the bridge, each corbel being 10 ft. long by 1 ft. 5 in. average width by 3 ft. 3 in. deep, and anchored down to the bridge by two bolts 1¼ in. in diameter. The parapets are 3 ft. 6 in. high, there being 1,452 balusters in the parapets. The amount of the contract was £95,484 exclusive of the lamps and lamp standards, and the work was completed within the contract time of two years. Mr. A. Murray, F.R.I.B.A., was the architecf, Mr. E. Cruttwell, M.Inst.C.E., being the engineer, and Messrs. Pethick Bros. the contractors.

The Proposed New Humber Dock.

According to Sir John Wolfe Barry's evidence before the Parliamentary Committee which has had under consideration the Bill promoted by the Humber Commercial Railway and Dock Company, the proposed new dock on the Humber at Immingham, near Grimsby, should be the finest on the East Coast. The scheme provides for main dock with a deep-water area of 38½ acres, the arms being 1,250 ft. long and 375 ft. wide. Three other arms could be made, and, in this event, the total deep-water area of the dock would be 71 acres. There would be at first 4,800 lineal feet of quay space; and when all the arms were finished, 12,300 lineal feet. The lock is proposed to be 750 ft. long and 85 ft. wide, with a depth of water on the sill of 47 ft. 6 in. at high-water of spring tides and 43 ft. 6 in. at high-water of neap tides, and 28 ft. at low-water of spring tides. The entrance channel is designed to have 29 ft. at low-water of spring tides. This would admit of the largest steamers entering the dock at any state of the tide. The Great Central Railway Company are co-operating in the promotion of the scheme, which involves the connection of their main line with the dock by a short railway. The estimated cost of the works is set down at £1,102,565, this including £75,710 for the connecting railway.

The Mono-Rail System.

One of the most notable English exhibits at the St. Louis Exhibition will be a working model of the Behr Mono-rail system. The model, which has been on exhibition in London, is built on a scale of ¾ in. to the foot, and comprises a circular track with motor-car. Embodied in this working model are a number of improvements which were recently described by the inventor at a meeting of the London Chamber of Commerce. In the course of his remarks, Mr. Behr pointed out that speeds were to be increased and express passenger trains multiplied, new rails must be laid to accommodate express traffic solely, and if these new lines were constructed on the mono-rail system, to follow the present rails and run into the same stations, a most beneficial effect would be produced on the receipts of the existing companies. They would be able to inaugurate a passenger service with at least double the speed of the fastest express trains, and by using their existing rails for local passenger and goods traffic only, they would evolve order out of chaos and punctuality out of an ever-increasing unpunctuality, would eliminate 99 per cent. of all the accidents that now occurred, and would effect a reduction in the costs of working and maintenance, which would enable them to increase their dividends while diminishing their charges.

Lowering the Sill of the Ramsden Dock at Barrow.

An interesting description of this work was given at a recent meeting of the Institution of Civil Engineers, by Mr. L. H. Savile, A.M.Inst.C.E. The contract for the work was let on June 8th, 1899, to Messrs. John Aird and Co., Mr. Frank Stileman being Chief Engineer. Besides the lowering of No. 4 sill, of Ramsden Dock by 6 ft., a quay wall, 900 ft. long, on the south side of the basin, and another, 500 ft. long, on the north side, had to be constructed. The contract was let on the understanding that these quay-walls were to be completed before the lock was closed for the lowering of the sill. The main object with which the work was undertaken was to allow large battleships being built by Messrs. Vickers, Sons, and Maxim to have access to the docks, as there was only 24 ft. of water on the existing sill, and the battleship then being built for the Japanese Navy, had a draft of 27 ft. 3 in.

On the completion of the quay-walls, cofferdams were built across the ends of the Ramsden Dock lock, and the water was pumped out, so that the work on the sill might be done in the dry. The operations involved in this work were: Removing the old gates; cutting away the old gate-floor; rebuilding the floor 6 ft. lower, so as to take a sliding caisson in place of gates; building a caisson-recess; and providing and installing a sliding caisson.

Special Difficulties Overcome.

Shortly after the lock had been pumped dry and the removal of the sill begun, an accident occurred through the water breaking under the pier-head on the north-east side of the lock, whereby the work was considerably delayed, as the cofferdam at the north end of the lock had to be lengthened before the water could be again pumped out. In consequence of this accident, which damaged the pier-head and showed the unreliability of the bottom, special precautions were taken in carrying out the remainder of the work; these consisted of driving cast-iron sheet piles in front of the old sill, and taking out the old floor in smal. squares. No further trouble was met with, and the new sill was completed on April 21st, 1901. The pier-head, which had been damaged by the water breaking through, was moved, and a timber head was built in its place. The cofferdams were now removed, the sliding caisson was launched and floated into the recess prepared for it on the west side of the lock, and the lock was re-opened for traffic on May 17th, 1901. The sliding caisson, which takes the place of the old gates, was designed to take a head of water on either side, thus doing the duty of two pairs of gates; it also serves as a roadway, 12 ft. wide, across the lock, for heavy vehicular traffic. The caisson is tank-shaped, 103 ft. long, 12 ft. wide, and 39 ft. 6 in. deep. It has four watertight compartments so arranged that the caisson does not quite float, thereby reducing to a minimum the friction when the caisson is being drawn across the lock. Hydraulic machinery is used for hauling the caisson to and fro, and also for working the sluices in the caisson.

ELECTRICAL AFFAIRS.

BY

E. KILBURN SCOTT, M.I.E.E., A.M.Inst.C.E.

Electric Lighting of the City of Westminster.

Mr. J. W. Bradley, the City Engineer to Westminster, is doing the electrical profession a great service by issuing quarterly reports on Street Lighting by gas and by electricity. The table below gives the statement of comparative costs extending over a period of eighteen months, and it will be seen that the lowest total cost per candle-power per annum is 8·7d. for electric arcs supplied with current by the Westminster Electric Supply Corporation. The average of all the electric lighting is 11·7d., whereas the average of the gas lighting is over 25d., and if after all these years gas cannot do better than the figures tabulated by Mr. Bradley it is a bad look-out for its future as a street illuminant:—

TESTS OF STREET LAMPS IN CITY OF WESTMINSTER, WITH STATEMENT OF COSTS EXTENDING OVER A PERIOD OF 18 MONTHS.

Description and Position of Lamps.	No. of Lamps in City, of Class specified.	Average Candle Power.	Total Cost per Lamp per annum.	Total Cost per Candle Power per hour.	Test No. 6. Total Cost per Candle Power per annum.	Average Total Cost per Candle Power per annum, including all tests up to date. (6 Series).	Total No. of Tests up to date.
			£ s. d.	d.	d.	d.	
Electric arcs (Charing Cross and Strand Electric Light Company), opalescent globes	100	**670**	30 0 0	·00273	10·75	**11·49**	40
Electric arcs (St. James's and Pall Mall Electric Light Company), Muranese globes	60	**474**	34 0 0	·00445	17·23	**15·1**	43
Electric arcs (Westminster Electric Supply Corporation), opalescent globes	945	**605**	22 0 0	·00222	8·73	**8·7**	35
Refuge lanterns, four mantles, Victoria Street	12	**113**	13 6 6	·0072	28·3	**30·7***	24
Sugg's high-pressure lamps, Parliament Street	29	**573**	18 5 0	·00194	7·65	**9·85**	35
Incandescent mantles, Victoria Street type	1,241	**42**	3 10 0	·00508	20·0	**18·42**	40
Triple flat flame, footway, Whitehall, now in process of removal, Scott-Snell lamps being substituted	35	**51**	6 1 2	·0076	29·9	**25·65**	33
Incandescent mantles, Carlton House Terrace type	251	**38**	2 17 11	·00465	18·3	**18·18***	27
Triple flat flame, Strand type ...	508	**47**	9 8 10	·0122	48·2	**47·44***	30

* Average of five series only.

Testing of Gas and Electric Light.

In making such tests as these the Sugg photometer is employed, and it is fitted with two and five candle standards for testing both low and high-power lamps. From its construction it gives results in all cases if anything slightly higher than the true values, but the error is constant, so that the comparison is correct. Precautions are necessary to guard against extraneous light reflection from buildings, obstruction by opaque objects, etc., and the readings must be taken on a clear night. In the case of incandescent mantles great variation in candle-power results from quite a *slight defect in the mantle*, and this is particularly the case with high-pressure lamps. This circumstance renders it difficult to form any comparison between tests carried out in a laboratory and those made under actual lighting conditions. Groups of incandescent mantles in particular are difficult to keep in order, and in a lantern the effective candle power does not by any means increase in the same ratio as the number of mantles.

Soldering Joints in Bulk.

Soldering by hand with an iron is one of those finicking things which should be banished from an electrical engineer's works as soon as possible. If solder must be used, it might just as well be done wholesale by first dipping the parts into flux and then into melted solder. With a little special design the joints between armature coils and commutator segments could be done in this way, and it has already been in vogue for some time on the Continent for soldering the conductors of short circuited rotors to the end rings.

Where joints are not suitable for soldering in this way there is no reason why, with a little scheming, such joints should not be mechanical. In many of the largest German-made dynamos the armature conductors are fastened to the commutator segments by several ¼-in. steel grub screws.

POWER STATION NOTES.

BY E. K. S.

Scale in Boilers.

It is generally supposed that scale in a boiler materially reduces the steam-raising efficiency by cutting down the heat transmission from the gases to the water, but, as a matter of fact, this heat transmission is seldom reduced more than ten per cent. The principal objection to scale lies in the fact that it seriously increases the wear and tear and endangers the safety of the boilers. In clean boilers the temperature of the furnace plate is nearly the same as that of the water, whereas in a scaly boiler the excess temperature may be about one-tenth of that of the flame; in other words, the temperature of the furnace plate may be raised by say 300 deg. F. In the first case when the furnace door is opened and cold air admitted the contraction of the furnace plate will be quite inappreciable. In a scaly boiler, on the other hand, the rapid reduction of 300 deg. F. means a contraction of nearly a quarter of an inch in a length of 10 ft. This is capable of setting up a stress of over 20 tons to the square inch and the constant straining due to the furnace door being opened and closed will, in due time, groove the furnace flanges.

Importance of a Roughened Surface in Boilers.

Those who have seen the old type Lancashire boilers under construction will have noticed that before the plates go to the marking-off table the surface is treated with a kind of chalky paint. At first sight it may seem that this is put on simply to throw up the scribing marks of the rivet holes, etc. There is, however, another purpose, and that is to roughen the surface so that the water will boil off it more readily. Rough points are necessary to give a nucleus for the small steam bubbles to rise from, for when water lies in contact with smooth metal it boils explosively. This effect may be noticed when boiling water in a glass test tube, a few grains of sand or other material immediately quietens the boiling.

The point to specially note in regard to this fact is, that whereas plates are easily treated to give this roughened surface, small diameter boiler tubes are not. It is just possible that various minor troubles with water-tube boilers are traceable to this fact.

Utilisation of Waste Material in Collieries.

There is an old proverb that "the cobbler's children are always the worst shod," and this would appear to apply to collieries, because there are probably no more wasteful engines in the world than those ordinarily used in collieries. A consumption of 4 lb. to 12 lb. of coal per horse-power per hour is quite common, and the boilers more often work at under 50 lb. per square inch than over. There are, of course, distinguished exceptions, because with the introduction of electrical plant many collieries are being brought up-to-date.

One direction in which colliery engineers might save a good deal is in burning the black coaly "bands," and small coal which is now thrown into the goaf as rubbish. By breaking up the "band" into small pieces in a stone-breaker and mechanically stoking it under forced draught, such material would give off a considerable amount of heat. Its utilisation in this way would not only be a saving, but would also reduce the chance of fire in the goaf.

We are asked to state that the type of Underfeed Stoker with steam-driven ram referred to last month in Power Station Notes, is made by Erith's Engineering Company, of 70, Gracechurch Street, E.C.—ED.

Improvements in Gas Producing.

Amongst recent improvements in gas producers may be mentioned that embodied in the Whitfield producer. In an ordinary producer air is usually injected by means of a steam-jet blower into the space below the inclined grate, and the gases produced by the passage of the air and steam through the fuel are drawn off from the top of the producer, along with the light hydrocarbons distilled from the coal.

Gas produced in this way is certainly large in quantity, but its calorific value is rather low, and it is, moreover, liable to be contaminated with tar vapour, which, if not carefully removed by subsequent washing, is liable to give trouble by depositing tar on any cool surface with which it comes in contact. If used for power purposes, this deposit may be on the engine valves, and it may seriously interfere with the proper working of the same. Such tar deposits, also, of course, represent loss of calorific value.

The characteristic feature of the Whitfield producer is the method of dealing with the volatile portion of the coal, namely, the hydrocarbons or tar vapours. Unlike most other producers the outlet is not at the top of the producer above the level of the fuel, but is at one side and below the surface of the bed of the fuel. The easily-volatilised hydrocarbons, driven off from the upper surface of the fuel, are collected by a steam injecting arrangement and forced into the incandescent fuel near the bottom of the producer, but above the zone of combustion. Here the steam in the jet is dissociated, the oxygen combining with the carbon of the hydrocarbons to form carbon monoxide, and passing away through the outlet to the gasometer.

It is important to notice that no air is admitted to the circulating pipe, the sole object of the latter being to draw off the volatile hydrocarbons and tar vapours evolved from the upper layers of fuel. By combining them with steam they are converted into carbon monoxide and hydrogen free from any diluent.

It may be mentioned that Messrs. W. F. Mason, of Manchester, are laying down these producers at the following places:—

Reading, 1,800 h.p. for Willans' gas engines; McMurray's Paper Mills, 800 h.p. for Willans' gas engines; Clement Talbot Automobile Works, 600 h.p. for Westinghouse gas engines.

The Use of Illuminating Gas for Engines.

The success of large engines working with poor gases, such as those from blast furnaces, has drawn attention to the fact that, generally speaking, illuminating gas is far too explosive. By burning slowly, poor gases do not bring such great stresses to bear on the fixed and moving parts, indeed, a blast furnace gas-engine works comparatively quietly.

The trouble with illuminating gas is due to the hydrogen present, and it might be worth while the gas companies considering how they can de-hydrogenise their gas for purposes of power. The writer assumes, of course, that they are anxious to increase their connection amongst power users. It is rather surprising that they have not hitherto investigated the matter; possibly it may be due to the fact that when gasworks are taken over by a municipality, an energetic, pushing management generally gives place to a sleepy irresponsible one.

IRON AND STEEL NOTES.

By E. H. B.

The Iron and Steel Institute.

The annual meeting of the Iron and Steel Institute will be held at the Institution of Civil Engineers on the 5th and 6th of May. The following is a list of Papers expected to be submitted:—"On Pyrometers suitable for Metallurgical Works" (Report of Committee).—"On Coke Ovens," by C. Lowthian Bell (Middlesbrough).—"On Troostite," by H. C. Boynton (Harvard University).—"On the Range of Solidification and the Critical Ranges of Iron-Carbon Alloys," by H. C. H. Carpenter, M.A., Ph.D., and B. F. E. Keeling, B.A. (National Physical Laboratory).—"On Explosions produced by Ferrosilicon," by A. Dupré, Ph.D., Chemical Adviser to the Explosives Department, Home Office; and Captain M. B. Lloyd, R.A., H.M. Inspector of Explosives.—"On the Thermal Efficiency of the Blast-Furnace," by W. J. Foster (Darlaston).—"On the Production and Thermal Treatment of Steel in Large Masses," by Cosmo Johns (Sheffield).—"On the Manufacture of Pig-Iron from Briquettes at Herräng, Sweden," by Professor H. Louis, M.A., Assoc.R.S.M. (Newcastle-on-Tyne). Reports on research work carried out during the past year will be submitted by C. O. Bannister (London), by P. Breuil (Paris), by K. A. Gunnar Dillner and A. F. Enström (Stockholm), by J. C. Gardner (Middlesbrough), by F. H. Wigham (Wakefield), by A. Campion (Cooper's Hill), and by P. Longmuir (Sheffield), Andrew Carnegie Research Scholars.

The Microscopic Analysis of Metals.

What should prove to be a standard work on the Microscopic Analysis of Metals, has been issued by Messrs. Charles Griffin and Company, Ltd., being an English translation of two papers by Mons. Floris Osmond, of Paris. The illustrations alone, covering a wide range of micro-photographs, render the work a most desirable addition to the reference library, and of the matter, it is only necessary to say that it is edited by that well-known authority on this side of the channel, Mr. J. E. Stead, F.R.S., F.I.C. The opening paper on "Metallography considered as a Method of Assay," was read before the International Association for the Testing of Materials in 1897 at the Stockholm Congress, and forms a suitable introduction to the second part on "The Micrographic Analysis of Carbon Steels." At the same time the author has added a chapter describing the micro and photographic apparatus employed, together with an appendix on Austenite. Of Mons. Osmond's work, Mr. Stead says: "Its unique value is due to the great accuracy of the author's experimental observations. The careful and logical reasoning and hypothetical conclusions arrived at have their charm, and none can carefully read them without feeling that they have been made by a master mind, whose one aim is to arrive at the truth." I may add that the descriptions are most clear, more especially that which concerns the author's method of fine polishing. This involves three successive operations, viz.: polishing in bas-relief, "polish-attack," and the action of suitable chemical reagents.

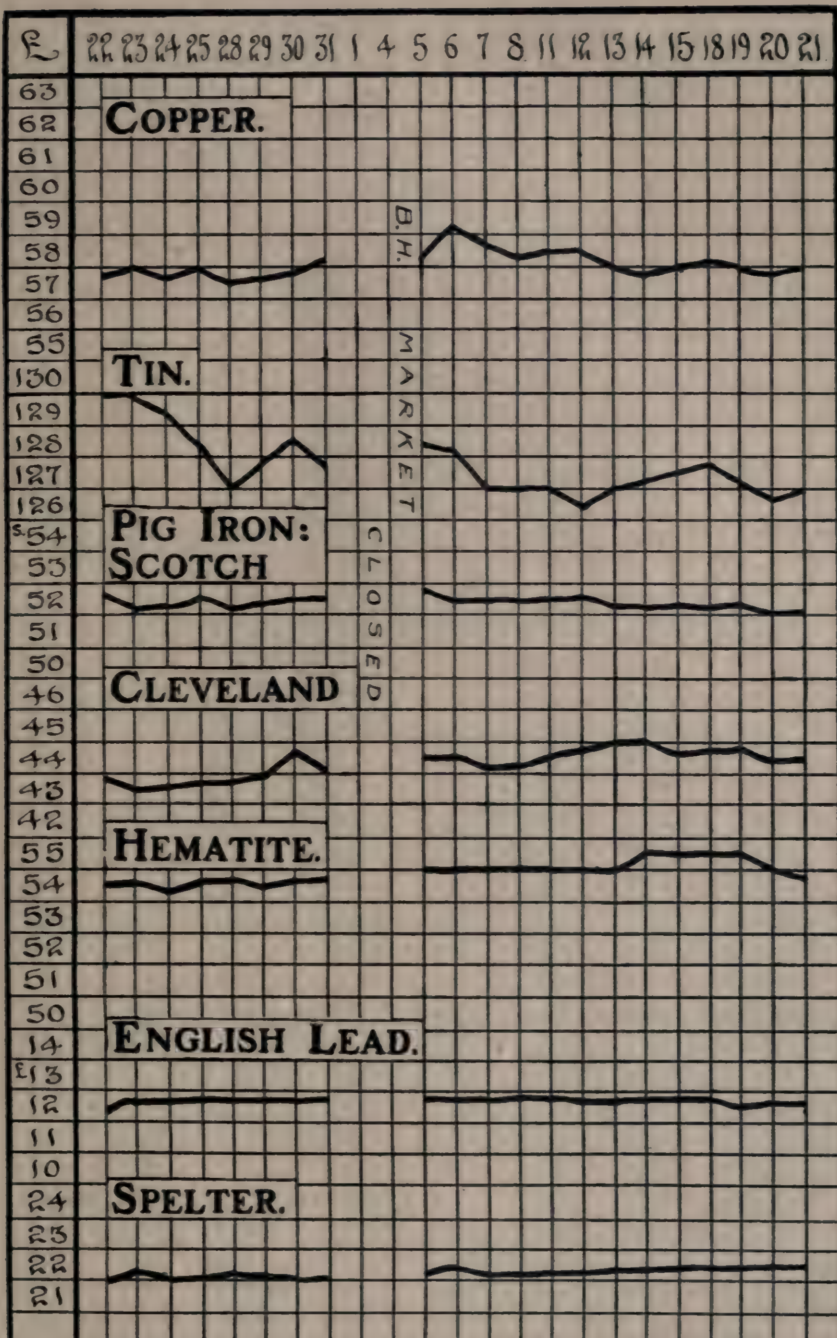
Formation of the German Steel Trust.

The German steel syndicate has at length been organised by twenty-eight of the largest concerns in the country, the smaller manufacturers, whose output ranges from 1,000,000 to 1,500,000 tons annually, being excluded. Twenty companies began the final movement, and reinforced their case with threats of ruinous competition against the independents, which they would keep up until they had driven them out of the markets of the world. These threats had the desired result, except in the cases of the Phœnix Steel Works and the Westfälische Steel Works. The demands of the Krupp Company, which were considered excessive, presented one of the greatest difficulties to the negotiators of the syndicate. The interested companies, however, reached a compromise with the Krupp Company, the allotment made it on an increasing scale reaching 700,000 tons on April 1st, 1907. It is stated that the head office will probably be either at Cologne or Düsseldorf.

Rail Steel and the Future of the Basic Open-hearth Process.

An interesting paper was that which Mr. Robert W. Hunt of Chicago contributed at the annual meeting of the American Institute of Mining Engineers, on Rail Steel. He remarked that, while some of them with experience covering the whole history of the manufacture of steel rails, were aware of the great differences in the conditions governing their production at various periods, he did not think the engineering world generally appreciated the direct and imperative influence those variations had had, and were having, upon the wearing quality of the rails.

In the earlier days the steel was poured into ingots which would make but two 30-ft. rails of not exceeding 60 lb. weight per yard—giving a mass weighing, say, about 1,400 lb., and of a section of about 12 in. square. To-day the ingots were some 22 in. square, and weighed more than 4,000 lb. Of course, the interior of the larger ingots must remain hot and liquid longer than that of the smaller ones, and from this condition arose the steel rail makers' *bete noir*—segregation of the metalloids and piping of the steel. The smallest-



THE HOME METAL MARKET.

Chart showing daily fluctuations between March 22nd and April 21st, 1904.

sectioned ingot would pipe, but with the increase of its size, so would be that of the interior cavity. This tendency existing and being well known, it would seem that rather than being ignored, especial care should be exercised to avoid the evils arising from it.

In the course of his paper, Mr. Hunt expressed his belief that the one question of ore-supply would in time, compel the increased use in that country of the basic open-hearth process. They could not for ever continue the rejection of ores which were in every other quality suitable for steel making, because their phosphorus-content was outside of the Bessemer limit. And if at the same time, by the use of the other process, they produced a better metal, at cost not much if any greater, the outcome was inevitable.

Phosphorus was the controlling element in rail-steel. If that could be practically disregarded, no one would deny the ability to make a better article, no matter for what purpose it might be intended.

So far as rails were concerned, the theory relating to the difference in the wear of the steel made by the two processes was being subjected to the crucial test of practice. But no matter what steel was used, care must be exercised in making it; in pouring the ingots; in their handling and heating; and in the rolling and straightening of the rails.

The Physics of Cast Iron.

According to Mr. Richard Moldenke, of New York the use of aluminium in the foundry is becoming more limited than it was, for the reason that it has been found to be injurious to the harder irons; that is, for hard irons the remarkable property possessed by the light metal of throwing out the graphite militates against its usefulness. For the soft varieties of iron, a small quantity of aluminium, added when gases are feared, s very good, but proper precautions in melting should make the need of this addition unnecessary. On the other hand, the use of titanium-iron alloys is to be commended, because the titanium reacts directly with any oxygen or nitrogen present in solution, and, as a consequence, a purification takes place which cannot be overvalued. Increasing the strength of an iron 20 per cent., without remaining behind as an integral part of the metal, seems to be the function of this new candidate for foundry favours. With regard to the addition of other metals, such as nickel, cobalt, etc., but little is heard about them in the foundry. These metals, or their alloys, are too expensive, and consequently it is more profitable to use steel castings for material of a strength greater than that of cast-iron.

At the conclusion of his remarks on the physics of cast-iron, Mr. Moldenke said the future of their studies seemed to lie in the devising of methods to control the chemical composition of cast-iron in cupola and furnace, irrespective of the nature of the pig and scrap charged. Thus we should be able to eliminate sulphur, and perhaps phosphorus, at will. We should also be able to remove the last traces of oxidation, which had been due either to the blast-furnace or to the cupola-furnace at some previous smelting. With those desiderata the field for the maker of foundry pig-iron would be greatly broadened and many an iron ore, now unsaleable, would find its way into the market, to the lasting benefit of the world's mineral resources.

Blast-Furnace Practice in the States.

At the same meeting Mr. F. Louis Grammer summed up the past decade in American blast-furnace practice. The administration of some plants was such nowadays, he said, that the superintendent had become a train dispatcher or a burden clerk. The present system required the superintendent to be more a reader of events and men, while the engineer became more concerned with new devices to harness nature.

In the most powerful companies this division of duties had usually resulted in good, but in those plants, like Saxe's razors, "made to sell," many mistakes had been made.

They could look around and see plants well arranged to make iron, but no iron mines to supply them. Others had fine mills, but no furnaces; others, no market. And so the whole decalogue of managerial sins, resulting from a bureaucracy or directorate of untrained iron men, could be run.

In looking over the development of furnace-practice, four steps or incidents appeared as the more important factors: (1) The use of waste gas under boilers; (2) the heating of the blast; (3) the use of coke as a fuel; and (4) the use of Lake ores. Each of these steps has resulted in a doubling and trebling of the output which was possible before their introduction.

Of course, improved refractory materials and better engines were essential, as was also a knowledge of chemistry, but these influences should be regarded as secondary and logical sequences to the others. The better application of the knowledge classified under these four heads represented the development in America.

A decade ago lines of furnaces and cooling devices occupied the thoughts of the furnace world. Since then the advances made might be classified under (1) Conveyors and other mechanical improvements; (2) Metallurgical by-products; (3) Miscellaneous.

The Height of Furnaces.

Impressive as was the metallurgical practice in America, it exhibited inventive ability less than natural resource. They owed more to the regions named after that emissary of peace, P.re Marquette, and the tribes he went out to civilise and Christianise (Menominee and Gogebic), than they did to original research. It was true they had the Uehling pyrometer of American origin, which was an instrument of great precision and of great value to the furnace-man. Their records, however, were characterised by bold application rather than new ideas.

Their high furnaces did not reflect great credit on their designers, though in justice it should be said that most furnace-men were not in favour of 100 ft. heights.

He had personally inspected more than sixty furnaces, and he found that the fuel-consumption, other conditions being equal, was lower on furnaces of from 70 to 80 ft. in height than on furnaces exceeding 90 ft. While Dr. Egleston's records did not include any very high or very large furnaces, the best fuel-consumptions he quoted were in furnaces in the neighbourhood of 75 ft. in height.

AUTOMOBILE NOTES.

By J. W.

Non-stop Runs.

The following are the conditions under which the Automobile Club will recognise long-distance non-stop runs on the road :—

The first consideration is that the run shall be an absolute non-stop run of the motor and the car, no stops of any nature whatever being admitted except for traffic purposes when the motor may be stopped if the driver is called upon to do so, so that any stop whether for tyres or other purposes will be considered as the end of the run.

Every run must start from the Automobile Club, or from the Club House of an affiliated Club, and indication of the intended length of the run and the route to be covered is to be given to the Technical Secretary of the Automobile Club at least a week before the date of the run.

Accumulators or other parts may be changed and fresh petrol may be picked up and put in the tanks so long as neither the car nor the motor is stopped for the purpose.

John o'Groats to Land's End.

The attempt to make an absolute non-stop run between John o'Groats and Land's End proved a failure, inasmuch that closed gates at level crossings barred the way, and droves of sheep twice compelled a halt. The journey was performed in 52 hours and 35 minutes, however, thus beating the record by nearly ten hours. The Argyll Car—an ordinary touring vehicle of ten h.p., was driven by Mr. Douglas Whitehead, relieved by Mr. R. Carlisle.

Motor for Commerce.

The Lord Justice Clerk of Scotland presiding at the annual meeting of the Scotch Automobile Club, remarked that automobilism was not going to be alone a sport of the rich, but a useful agent in the commerce of the country. He was sanguine that during the next three or four years the public would recognise that there was no worse way of carrying locomotion into the country than by turning roads into electric railways. Motors could adapt themselves to the necessities of traffic, and could confer the greatest possible benefits on the public.

We note with interest that the Automobile Club is organising a parade of motor delivery vans.

The object is to encourage the drivers of these vehicles to pay careful attention to their vehicles with a view to reduction of wear and tear and cost of up-keep. Prizes to the amount of £50 will be given to the drivers for the best kept vehicles. A successful service of motor parcel-vans is now in regular operation between Birmingham, Coventry, Kenilworth, Leamington, and Warwick.

The Side-slip Trials.

The cars fitted with non-skidding devices and entered for the Automobile Club's Side-slip Competition, have been engaged in running off the preliminary endurance test of 850 miles. The first prize is to be not less than £100, and may be twice that amount at the discretion of the judges. The actual side-slip trials will be held on the 7th inst., on the private motor track of the Clément-Talbot Company, Ltd., at Ladbroke Grove, Notting Hill, which is being specially coated for the purpose. The following entries are stated in the official programme :—

1. Mr. Samuel Butler—Flat discs on tread held on by steel stems passing through the cover.
2. Mr. H. S. H. Cavendish—Single disc running on ground between back wheels.
3. Mr. W. Hunt—Double roughed discs running on ground between back wheels.
4. Mr. W. Maitland Edwards—Detachable leather band fitted with steel segments riveted thereto.
5. Messrs. Rourke and Horsborough—Double discs running on road between back wheels.
6. Mr. Alex. Nicholson—Steel blades on back wheels with springs; not touching tyres and lifted from contact with road by lever.
7. Mr. Mark Vivian—Tread consisting of alternative sections of hard and soft rubber.
8. Wilkinson Tyre and Tread Company—Fine steel wire staples embedded in tread.
9. W. Jenkinson and Co.—Detachable leather ribbed cover.
10. Commander Chas. Scott — Detachable wire-woven zigzag band on tread, kept in place by side wires.
11. Sainsbury's Anti-Skidders—Spring fork carrying blades each side of tyre, supported on rim.
12. M. L'Empereur—Steel plates connected by links fitted on tread, detachable and kept on by inflation of tyre.
13. Messrs. Grose, Ltd.—Leather band with steel studs.
14. Messrs. Parsons Non-Skid Company—Detachable chains on tread.
15. Messrs. The Civil Service Motor and Cycle Agency, Ltd.—Detachable leather cover fitted with steel studs (Billet).
16. Gare Patent Tyre Company—Combined wood, rubber, and steel wheel.

Numbers 10, 13, and 16 had been withdrawn at the time of going to press.

AMERICAN RÉSUMÉ.

BY OUR NEW YORK CORRESPONDENT.

NEW YORK, April 19th, 1904.

The American Mechanical Engineers.

The American Society of Mechanical Engineers will hold its summer meeting in Chicago, beginning on May 31st, and continuing till June 3rd. The meeting is to be a joint session with the Institute of Mechanical Engineers of Great Britain, and nearly 200 members of the British Institute have expressed their intention of taking part in this meeting.

The New York Rapid Transit Subway.

According to "Machinery," it is expected that the New York Rapid Transit Subway will be opened to the public in June. The work has been a colossal undertaking, not so much on account of the vast quantities of earth and rock to be removed, but because of conducting it in a crowded city through streets carrying a great volume of traffic and beside tall buildings whose foundations were threatened by the excavations. In addition there were the multitude of water pipes, sewers, gas mains, electric conduits and pneumatic tubes with their surface connections, etc., that had to be displaced bodily without interruption of their service or with as little as possible. This work alone is said to have cost the contractors fully $3,000,000. For the greater part of the route, the tunnel was carried on by the "cut-and-cover" plan; that is, it was dug as a ditch and covered over by a roof carried by steel structural work. The tunnel is finished in white glazed brick or tile, and the stations are the same with coloured trimmings, the colour scheme being varied for each station.

World's Gold Output.

According to figures published by the New York "Commercial and Financial Chronicle," the gold output has during the past twelve months increased by 1,456,872 oz., namely 15,894,541oz., against 14,437,669 oz. in 1902. The countries produced as follows:—

	1902.	1903.
Australia	3,949,394 oz.	4,299,234 oz.
Africa	1,998,811 ,,	3,317,662 ,,
United States ..	3,870,000 ,,	3,600,331 ,,
Canada.. ..	1,003,359 ,,	943,314 ,,
Russia	1,100,000 ,,	1,134,000 ,,
Mexico.. ..	491,156 ,,	500,000 ,,
Other Countries	2,024,949 ,,	2,100,000 ,,
Total ..	14,437,669 oz.	15,894,541 oz.

The greatest increase was in South Africa and Australia, whereas the United States and Canada fell behind. The American output was influenced by the strikes in Colorado, by the drought in California and by the temporary closing of gold and copper mines in Montana.

At the World's Fair.

Among prominent features of the World's Fair may be mentioned a complete metallurgical laboratory with assay department, in operation, the work of the laboratory being done by students of the Colorado School of Mines. The equipment consists of a coal furnace and two gasoline furnaces, with the necessary accessories, four desks for chemical work, and a dust-proof balance room enclosed in glass. There are also eight cases for general display. Regular assays will be made to show the methods of work, and specimens submitted by visitors will be assayed free of charge.

The United States Navy has an elaborate exhibit occupying a floor space of 200 ft. long by 77 ft. wide. It is designed to give an intelligent idea of the internal and external features of American men-of-war, weapons and their use, of the great graving and floating docks in which fighting vessels are placed for repairs, as well as a representation of the actual life and duties of the officers and enlisted men of the navy and Marine Corps afloat and ashore, in war and in peace, together with the Government's facilities for educating officers and its methods of enlisting and training men and boys who compose the fighting personnel of the United States Navy. The biograph will play an important part in illustrating every day life in the navy.

Carnegie Gift.

If it be true that the object of Mr. Carnegie's gift was to demonstrate to the world the spirit of reciprocity and co-operation which pervades among American technical men, a spirit which he found lacking in Great Britain, where, as he put it, each engineer is apt to be an island, the "demonstration" is hardly convincing. The Civil Engineers were against inclusion by a vote of 1,139 to 662. The deciding factors in arriving at this decision by the Civil Engineers were, says a contemporary, doubtless as follows: The possession of a handsome building of their own, practically paid for; the disinclination to merge the fund representing this investment in a building where the American Society of Civil Engineers would be one of four tenants and have a corresponding fraction of control; and finally, the belief—well founded or otherwise—that there would be a decided loss of prestige in abandoning the independent position won through years of patient and hard work.

Be this as it may, it will be noted that Mr. Carnegie is in no wise perturbed. He has renewed his munificent offer to the remaining societies, viz.: the Society of Mechanical Engineers, the Institute of Mining Engineers, the Institute of Electrical Engineers, and the Engineers' Club of New York, and the offer has been cordially accepted.

Some Suggestions and What Came of Them.

Boxes for suggestions by workmen are all very well in their way, but the experiences of Mr. Frank Holz, of the Cincinnati Milling Machine Company, tend to show that they do not pay in the long run. The plan was to pay the employee for any really valuable idea given to the company. The box was filled with many useless suggestions, but one or two were good, and were adopted. For one of these suggestions an employee received $200, and he was advised to take his money home and tell his people how it had come to him. The result was that he did not come back for several days, and when he did come back again, he was not worth much for work. Another employee who received an equal amount, spent it in gambling and on other bad habits, which well-meant

advice and warnings did not break up. Many smaller rewards were paid for minor improvements, but these resulted in contentions and jealousy, so the scheme was finally abandoned. Nevertheless, out of its ashes there arose, Phœnix-like, a better plan, involving monthly meetings of the heads of all departments, shop foremen, and employers. Some shops have found these meetings of such benefit, that they hold them once a fortnight. They have been found to promote a better understanding between the men and their employers.

Consumption of Pig Iron.

The following table from the Bulletin of the American Iron and Steel Association shows the consumption of pig iron in the United States during the last two years.

The comparatively small quantity of foreign pig iron held in bonded warehouses has not been considered. Stocks in foundry yards and in the yards or producers who do not sell their pig iron, always unknown quantities, are necessarily excluded. So also are the stocks held by rolling mills and steel works whose owners do not make pig iron. Warrant stocks are included in unsold stocks.

Pig Iron—Gross Tons.	1902.	1903.
Domestic production	17,821,307	18,009,252
Imported	625,383	599,574
Stocks unsold January 1st ..	73,647	49,951
Total supply	18,520,337	18,658,777
Deduct stocks December 31st	49,951	598,489
Also exports	27,487	20,381
Approximate consumption ..	18,442,899	18,039,907

It will be observed that, while the production of pig iron in 1903 shows an *increase* of 187,945 tons over 1902, the consumption shows a *decrease* of 402,992 tons. The significant fact that the imports of pig iron in 1903 were almost exactly the same as the unsold stocks on hand at the close of the year will not escape attention.

Calculated in the same way as in the table the consumption of pig iron in 1901 amounted to 16,232,446 tons, as compared with 13,177,409 tons in 1900, 13,779,442 tons in 1899, and 12,005,674 tons in 1898. The increase in consumption in 1902 over 1901 amounted to 2,210,453 tons, and in 1901 over 1900 to 3,055,037 tons. In 1900 there was a considerable decrease in consumption as compared with 1899, the falling off amounting to 602,033 tons, while in 1899 the increase in consumption over 1898 amounted to 1,773,768 tons. Below is a table which gives the consumption in the last six years :—

Years.	Tons.	Years.	Tons.
1898........	12,005,674	1901........	16,232,446
1899........	13,779,442	1902........	18,442,899
900........	13,177,409	1903........	18,039,907

America and Standardisation.

At the annual meeting of the American Institute of Mining Engineers, Messrs. W. R. Webster and E. Marburg reviewed the progress made in the standardisation of specifications for iron and steel in both England and America.

When the International Association for Testing Materials was organised at Zurich in 1895, a committee was appointed, charged as follows :—

"On the basis of existing specifications, to seek methods and means for the introduction of international specifications for testing and inspecting iron and steel of all kinds."

The American representation on this international committee consisted originally of five and now of eight members. In view of the magnitude and importance of the subject, the Executive Committee of the American Section of the International Association for Testing Materials, since incorporated as the American Society for Testing Materials, appointed a committee of thirty-four members, including the American members of the above-named international committee, to frame standard American specifications for iron and steel. This committee reported on specifications for (1) Structural Steel for Bridges and Ships ; (2) Structural Steel for Buildings ; (3) Open-Hearth Boiler-Plate and Rivet-Steel ; (4) Steel Rails ; (5) Steel Splice-Bars ; (6) Steel Axles ; (7) Steel Tyres ; (8) Steel Forgings ; (9) Steel Castings ; (10) Wrought Iron.

These specifications were designed to be fairly representative of the best current American practice, and were adopted by letter-ballot of the Society in August, 1901.

The leading engineering societies have participated at various times in the discussion of these specifications and have lent valuable assistance through the appointment of special committees on like or closely related subjects.

It is shown that the existing differences between the leading American specifications framed within recent years are in the main on matters of minor importance, and what has been done has resulted in a considerable clearing of the atmosphere. That further efforts will be put forth to reconcile the remaining differences as far as possible cannot be doubted. If the task be approached in a fair and open spirit of compromise between interests whose divergence, broadly viewed, is more apparent than real, all parties will be the gainers. If this work be promptly initiated, it is not too much to hope that American standard specifications approved by the leading technical societies, and covering the principal iron and steel products, will be available for presentation at the Seventh Session of the International Railway Congress to be convened in Washington, D.C., in May, 1905, and that they will prove an important step towards the ultimate realisation of international standard specifications.

SOUTH AFRICAN RÉSUMÉ.

By Our Johannesburg Correspondent.

JOHANNESBURG, April 12th, 1904.

Transvaal Quarterly Output.

The following figures from the usual official source show the mineral output of the Transvaal for the last quarter of 1903 :—

GOLD.

Month.	Yield in oz. Fine.	Value in £ sterling.
October	285,550	1,212,935
November	280,803	1,192,778
December	287,811	1,222,545
Totals	854,164	3,628,258

SILVER.

Month.	Yield in oz. Fine.	Value in £ sterling.
October	33,366	3,623
November	33,402	3,624
December	31,407	3,439
Totals	98,175	10,686

COAL.

Month.	Tons sold.	Value realised at pit.
October	195,190	74,718
November	186,060	70,916
December	192,784	73,307
Totals	574,034	218,941

DIAMONDS.

Month.	Carats.	Value £.
October	28,895	39,931
November	29,701	40,077
December	30,120	41,298
Totals	88,716	121,306

Increase in Diamond Output.

In June last the Transvaal produced only 15,425 carats, so that the output has been practically doubled during the last six months, and at present the monthly production is nearly equal to the total for the statistical year ending June, 1903, which amounted to 33,573 carats. But even now the Kimberley district alone produces ten times as many carats as the whole of the Transvaal.

Natal Ports.

This enterprising colony continues its efforts to secure its share of the South African trade. The result of the dredging at Durban showed a record channel during February, when the *Essex* steamed across the bar with a draught of 24½ ft. During the same month the floating dock was safely towed into the harbour and placed in position with the accompaniment of a seven-gun salute and the cheers of thousands of spectators.

A detailed survey which will occupy several months is to be made of St. Lucia Bay, to which reference has been previously made in these notes, as a possible new port for this colony in Zululand.

Durban Electric Lighting.

At the annual dinner of the Corporation Electric Light Department, held recently, in Durban, the great expansion of the supply was referred to, and it was stated that, whereas the plant started in 1898 with 196 connections and 9,320 lamps, there are now 2,209 connections and 90,000 lamps. There are also 700 incandescent street lamps and 190 arc lamps of 1,000 candle-power, which, as well as the power for trams, have to be supplied from the central station. The power provided is 4,325 h.p.

Orange River Colony.

The stagnation in the Transvaal Mining industry, due to want of coloured labour, is reacting upon the Orange River Colony, where relief works are being carried on to alleviate the distress amongst the white population. At the present time railway cuttings are being widened in view of the future doubling of the lines in order to find employment for the men who come to the relief camps.

In order to broaden the industrial conditions of the colony, a commission has been appointed to report upon the possibility of promoting, by means of Government assistance, the establishment of new and minor industries for which the necessary raw materials are now available. The following list of suggested enterprises, which may be considered and reported upon by the commission, may be of interest to European makers of industrial machinery: Spinning, weaving, blanket, carpet and basket making, leather tanning, with manufacture of boots and harness; the making of jams, biscuits, and cigars; preparation of oatmeal, cornflour, starch, chicory, indigo, manufacture of furniture, rope, pottery, tiles, cement, etc.

It is obvious that the above list includes some articles which could not be manufactured profitably on a small scale without the imposition of distinctly protective tariffs, and others which would need the importation of specially skilled workmen for their production.

Mining Costs in Rhodesia.

The Rhodesian Chamber of Mines has issued the following details showing the relative costs of labour and materials in their mines, with a view to emphasising the necessity for the lowering of railway rates wherever possible, these forming an important part of the total cost of supplies. The data are compiled from the returns of eight producing mines, which have produced over 95,000 ounces of gold bullion :—

Items.	Cost.	Percentage of total.	Cost per oz. s.	d.
Salaries	21,144	7·47	4	5·09
White wages	55,208	19·50	11	6·48
Contractors	9,020	3·19	1	10·63
Native wages	46,076	16·27	9	7·56
Fuel and charcoal £36,203				
Natives' food .. 22,089				
Other stores .. 72,831				
Total "supplies"	131,123	46·32	27	4·92
General expenses ..	20,530	7·35	4	3·48
Totals ..	£283,101	100·10	59	2·16

GERMAN RÉSUMÉ.

BERLIN, April 22nd, 1904.

German Exhibits at St. Louis.

Germany is to be well represented at the St. Louis Exhibition in spite of fears to the contrary. Among the exhibits may be mentioned: Machinery—steam engines, 8 exhibitors, including the famous "Vulcan" Works at Stettin; power machines of various kinds, 1 exhibitor; general adjustments for machine-working, 6 exhibitors; machine tools, 6 exhibitors. Electricity, electric lighting and electricity in its various uses, 7 exhibitors. Traffic and transportation, carriage building, automobiles and cycles, 7 exhibitors, including Benz and Co., Mannheim, the Daimler Company, Cannstatt, Continental Caoutchouc and Gutta Percha Company, Hanover, and the Mitteldeutsche Rubber Goods Works, Frankfurt a. M. Railways, terminals, stations, freight depots, and equipment in general under the auspices of the Prussian Ministry of Public Works, 9 exhibitors, including Siemens and Halske, Berlin, Henschel and Sohn, Cassel. Equipment for mercantile marine, 9 exhibitors, including both the great German steamship lines—one firm exhibits naval material and equipment. Ballooning and aereonautics, 6 exhibitors.

Mining and smelting works; collective exhibit arranged by the Royal Prussian Ministry for Trade and Commerce, 21 foremost German firms. Minerals stones, and their employment, collective exhibit of the amber industry, 16 exhibitors. Metallurgy, 3 exhibitors.

Among those exhibiting in the group for geographical, cosmographical, and topographical maps and requisites are: Justus Perthes, Gotha, Dietrich Reimer, Berlin, publisher of Kiepert's atlases and maps, Velhagen and Klasing, and others. The collective exhibit of German art photography includes 34 professionals and 24 amateurs, among the latter the Lette Verein of Berlin. Engineering models, plans, drawings, and public works, which group is under the auspices of the Prussian Ministry of Public Works, includes 10 representative firms, such as the Siemens-Schuckert Works and the Augsburg-Nuremburg Machine Works. The builders of the new Teltow Canal are also represented in this group.

Cutlery goods, processes and products, 3 exhibitors; gold and silverware, 13 exhibitors; marble, bronze, cast and wrought iron objects, showing equipment, process and output, including leading Berlin and Munich firms, 30 exhibitors.

A Proposed Overhead Railway.

For a long period, engineers have been considering the question of a North to South quick transit railway in Berlin. Mr. D. Feldmann has been describing, in the German technical press and "Railway Bulletin" a method of construction which he claims would be the cheapest and most efficient method. The proposed railway would run between Anhalt and Stettin stations. To run such a railway at street level, says Mr. Feldmann, or at such a height as the old City Railway or as the Siemens Elevated Railway, is, of course, quite out of question. The houses and buildings which would have to be pulled down or interfered with would involve enormous expense, and going across *Unter den Linden* would never be permitted. On the other hand, a four-track underground railway, with sufficiently large stations and with the severe gradients necessary would, even if at all possible, be far too costly.

Thus the construction of a North to South railway seems only possible from the technical as well as the economical point of view, if the railway is sufficiently high above ground to cross over the houses and not to interfere with any of them, except, perhaps, with the roofs of a few exceptionally tall buildings. At first sight, this proposal would appear to be a bold one, but careful consideration shows that a plan and method of construction can be devised, which appears comparatively easy of execution, or at least worthy of all attention.

The clear height must amount to 82 ft. to 98 ft. 5 in., and the spans must vary between 197 and 295 ft. Very many bridges of similar heights are in existence; there are even viaducts three and four times as high. The intermediate piers can be placed without difficulty either in the courtyards or over and in the rear building. There is no reason why all the spans should be of uniform length; similarly the shape and dimensions of the piers can be made to suit the different localities. Not many rear buildings will have to be interfered with, and the compensation to be paid will be comparatively limited in amount.

The two pairs of tracks can be placed side by side or one over the other. The latter arrangement is however only to be adopted if electric traction is used on the lower pair of tracks, which are those carrying the City and Girdle Railway trains. The best route for this new City Railway would be approximately central to the blocks between Charlottenstrasse and Friedrichstrasse. The line from the Stettin station to where it crosses the Kochstrasse can be absolutely straight, which would be of great advantage from the point of view of construction. To put up the usual scaffolding along the whole route would be quite impracticable; but, owing to the straightness of the line, it will be possible to build it while using hardly any scaffolding.

Proposed Method of Construction.

A little before Stettin station, the new railway will curve somewhat to the left. It appears advisable to erect, in the same straight line as the straight part of the track, a stage next to the station buildings and over the goods station, such stage being of sufficient length to deal with the largest span on the new railway. The material used for construction will be brought on trucks below this stage, or alongside it; the spans are then to be constructed there, or at least their main parts put together, and then the whole construction, as and when put together, is to be pushed forward to the south until the front end reaches the Kochstrasse.

The intermediate supports will, of course, have to be put up previously, by means of special scaffolding; and if they have not sufficient stability of themselves, they can be guyed temporarily by the use of wire ropes or other devices. At the top of them rollers are to be placed, over which the completed track can roll. As soon as the friction becomes so great, that the track can no longer be pushed on from Stettin station, the rollers are to be rotated so as to assist the advance of the track. Whether continuous girders or separate independent girders or any other girders are used, the whole track is in the first instance put together as a continuous girder by temporary connections, and these connections are only removed when the girders are in place—that is, when the whole is completed. In calculating out the girders, the stresses produced during the operation of pushing on the track must be allowed for.

At the front end of the track the projecting part will have to be of special construction, to prevent too great flexion when free and overhanging.

MINING NOTES.

BY A. L.

Coal Cutting by Machinery.

A remarkable extension in the use of coal-cutting machinery is evidenced in the twenty-eighth annual report of the chief inspector of Mines, Ohio, for 1902. Mr. Biddison points out that in 1889 only 900,000 tons (or about 8 per cent. of the output) were produced by machine, as compared with 13,439,648 tons (or 55 per cent.) in 1902. During 1902 there was a gain of thirty-three in the number of mines using machinery, whilst the number of machines at work increased from 429 to 574. Of the total number of machines at work, 527 were of the electric type and 47 compressed air. Mr. Biddison says the time is not probably far distant when the use of the pick will be discontinued, and that the use of machinery will permanently take its place as the most successful method of mining coal.

A Reference Work for Miners.

I have received from Mr. M. Walton Brown a copy of his carefully compiled "Subject-Matter Index of Mining, Mechanical and Metallurgical Literature for the year 1901." This is arranged as follows: Contents—Alphabetical List of Publications Indexed—Geographical Index to the Alphabetical List—Subject-Matter Index—List of Authors. The Subject-Matter Index, which occupies the greater part of the work, includes the following headings: General, Geology, Mineralogy and Crystallography, Chemical Investigations, Physical Investigations, Surveying and Levelling, Mining Technology, Quarrying Technology, Metallurgy, Salt-works, etc., Chemical Industries, Ceramic and Glass Industries, Building Construction and Materials, Machinery, Electrical Investigations, Navigation, Surface Transport, Railways and Tramways, Administration and Statistics, Directories, etc.

Mining in New South Wales.

The aggregate value of the mineral wealth produced in New South Wales to the end of 1903 is estimated at £158,339,798. The value of the production for 1903 is £6,059,486, and is a net increase of £421,341 over that of the previous year. The total number of persons employed in and about the mines of the State during the year under review is computed at 37,739, and is an increase of 4,044 persons on the year 1902. The estimated total value of the machinery erected at the mines, other than coal and shale mines and inclusive of the value of the dredging plants, is £2,097,710. This does not include the value of the plants of the various smelting companies. The gold yield for the year was 295,778 oz. crude, equal to 254,260 oz. fine, valued at £1,080,089. In addition gold to the value of some £612,334 was obtained by the smelting companies from auriferous ores imported from other States and treated here. It has to be explained that the system of collecting the gold yield has been revised, and in connection with that of the year 1903 an apparent decrease of £744 is shown in the value as compared with the production recorded for 1902, but the returns for 1902 include gold obtained by the smelting companies from imported ores, whilst those for the year 1903 are confined wholly to gold won from ores in the matrix and from alluvial deposits mined in this State. Instead, therefore, of a decrease occurring, there is actuallly an increase of £395,059 in the value of the gold won in this State during the year.

Miners' Phthisis.

At a recent meeting of the Mining Institute of Scotland, Mr. James Barrowman, in the course of a paper on "Miners' Phthisis," drew attention to the fact that the conclusions of the Miners' Phthisis Commission with regard to the highly dangerous nature of the dry dust in the mines of the Transvaal have been strikingly corroborated by the experience of those engaged in the construction of the Simplon tunnel. Arrangements are there made whereby all drill-holes are bored wet, and systematic measures are carried out to lay the dust. Cases of phthisis are rare among the workmen there, whereas in the St. Gothard tunnel-works where the same precautions were not taken, the mortality from phthisis was very high. It is much to be desired that the results of the investigations of this Commission should be known as widely as possible, in order that the urgency of reform may be brought home to all concerned. It should not be inferred, however, that death is being dealt out in similar fashion in the mines of this country. So far as Scotland is concerned, the lead-mines of Wanlockhead and Leadhills are the only metalliferous mines of considerable extent, and the working conditions there are quite different from those of the gold mines of the Rand, the drilling being done entirely by hand and water being abundant. And, as for coal-mining, practical experience and expert research make it clearer every day that lung-disease as a result of breathing coal-dust is not a prevalent disease among colliers. Unlike the sharp and irritating dust produced in the mining and tunnelling of hard and gritty rocks, the dust of coal is softer, more rounded, and comparatively harmless. The only conditions in coal-mining at all approaching those of the Rand gold-mines may be on the rare occasions where, in a dry colliery, long stone-mines or drifts are driven in gritty rock, without arrangements being carried out for watering the drill-holes. No doubt the dust of coal-workings always has a certain admixture of gritty particles derived from the strata connected with the coal, and this is an element worthy of some consideration from a sanitary point of view.

The World's Copper Output.

The world's copper statistics, compiled by Messrs. Aron Hirsch and Son, and published in detail by the "Mining Journal," show a remarkable increase, attributed to the fact that improvements in technology have rendered many old mines remunerative at greater depths, while the numerous advances in haulage appliances have enabled levels to be worked at a profit which in earlier times had to be abandoned.

Remarkable fresh discoveries of copper have also been made in all parts of the world. Only in this way can it be explained that the total production of the globe which in 1801 amounted to only 9,000 tons, had risen in 1850 to 30,000 tons, while since that date the production has progressively increased to 542,470 tons in 1902 and 589,361 tons in 1903, whereas in 1891 we only had a total production of 279,309 tons. The total output therefore has nearly doubled in the short period of a single decade. The lion's share in this rapidly increased production falls to America. The United States produced in 1891 128,175 tons, and in 1903 318,861 tons. In 1880 the production of the United States was only 27,000 tons. In 1891 the production of Mexico was 900 tons. In 1903 it was 48,000 tons.

OUR TECHNICAL COLLEGES.

By A TECHNICAL STUDENT.

Education and Business Success.

Little time has been lost in issuing the report of the Mosely Education Committee, which, we need scarcely remind our readers, was based upon the idea that education must be responsible for much of American success in business. Mr. Mosely is personally convinced that honesty, doggedness, pluck, and many other good qualities possessed by Britons, though valuable in themselves, are useless to-day unless accompanied by practical up-to-date scientific knowledge, and such knowledge only becomes possible with an enlarged and enlightened system of education, such as the United States possesses.

There is no doubt much truth in this observation, but, as Mr. Papillon has pointed out, there are other equally potent causes of American success. "The energy, 'hustle,' and inventiveness of the American character; the early hours and absorbing claims of business; the universal high-pressure race for wealth; the close touch between employers and employed, and readiness to act upon the view that capital and labour have common and not antagonistic interests; and, it is to be feared that we English must add, the greater sobriety of all classes among them—these are pushing America to the front."

Education, says Mr. Papillon, though a contributory cause, has not hitherto been the chief cause of American industrial progress. It has shared and is sharing in that progress, or, as President Roosevelt puts it, "education will not save a nation, but no nation can be saved without education." Strong emphasis is laid upon the fact that in America educational progress has been helped on by the goodwill of the people and their universal belief in its value as an investment.

American Methods Not Perfect.

At the same time, it has been rendered quite clear that the Americans are, as it were, merely groping their way to the successful determination of educational problems. Professor Armstrong does not hesitate to say that the entire system of education, both here and in America, seems to require reconstruction from bottom to top: "it would be well, if I may say so, if we could scrap the whole wretched academic show, and start afresh, in order that it may be greatly improved in quality and shortened in duration."

That American methods are not perfect seems to be well recognised across the Atlantic. For instance, the "Electrical World and Engineer," discussing Dr. Walmsley's recent investigations under the heading "As others See us," remarks that he (Dr. Walmsley) "puts a keen analytic finger on the very points which we have often recognised as weak spots in American technical education. His many conversations with American manufacturers brought out as the most general criticism 'that in many cases the training is too superficial and too apt to overload the student with a large and confused assortment of facts instead of training him in principles, this being in a large measure due to attempts to deal in too much detail with a crowd of subjects, especially in the last year of the course." And with respect to one egregious fad in recent education, Dr. Walmsley remarks: 'It is a matter for serious consideration whether the excessive amount of time given to manual work in the manual training schools has not been dearly purchased at the expense of starving the time which should have been given to mental training.' We wish that some of our strenuous and solemn-visaged educators who spell themselves in large capitals and have so little sense of humour as to take themselves seriously, would cut out these two quotations and paste both into their hats. As things are at present, the higher technical institutions are busy for no inconsiderable part of the course in stopping the gaps left by kindergarten foolishness of various sorts in the primary and secondary schools. They admit students at eighteen or nineteen years of age and then spend the better part of two years in teaching them the elementary English, mathematics and modern languages that have been neglected in the secondary schools to make room for nail-driving, music, painting, and emasculated physiology. It is vast credit to the technical schools that in a four-years' course they can turn off the material they do in spite of inefficient preparation. Our English friends, in trying to build up a system of technical education will at least have less foolishness to contend with at the start. The thing most needed over there, however, is the sympathetic assistance of the great universities. So long as they hold aloof from directly encouraging technical students, the tremendous weight of their centuries of social influence will stand against improvement."

A Sir William Allan Scholarship.

The Principal of the Sunderland Technical College (Prof. B. Branford) has laid the following letter, which he has received, before the Higher Education Committee:—

15, Humbledon View, March 11th, 1904.

Dear Sir,—Confirming our interview of to-day, I beg to intimate, on behalf of Lady Allan, that she is prepared to found a scholarship, or prize, at the Technical College, on the following terms:—

1. A capital sum of £500 to be invested in the names of three trustees, the interest on which investment would form an annual fund available for the scholarship.

2. The scholarship to be always called "The Sir William Allan Scholarship."

3. The scholarship to be only open to *bona-fide* apprentices at marine engineering works in the town (that is, on the Wear).

As to the details, and as to whether the scholarship should be awarded annually or triennially, Lady Allan will be glad of the vews of yourself and your committee, which she will consider very favourably.

Will you kindly lay the matter before the Technical Education Committee for their consideration?—I am yours faithfully. (Signed) Walter B. Allan.

To Principal Branford,
Technical College, Sunderland.

The Committee have passed a resolution thanking Lady Allan for her generous offer, and intimating that the matter would be sent forward for the consideration of the whole Education Committee.

Engineering Ideals.

Sir W. H. White, distributing the certificates gained by successful students at the Crystal Palace Company's School of Practical Engineering, said that twelve years ago he attended the school to perform the same pleasant duty which he was about to do that day. On the former occasion he went carefully through the school, and he had done so again that morning; and he was much pleased to be able to say that the good features which he noted twelve years ago had been maintained. Many new features had been introduced, adding greatly to the utility of the school, and the number of students was still fully kept up—the number which those who were charged with the conduct of the school desired to have. The number of students might be increased no doubt, if the instructors were increased also; but, in his judgment, the number upon which the school was based by the father of the present principal, —namely, 100—was a good one, for it was desirable to restrict the number to within the limits which ensured personal attention being given to each student. The school was founded in 1872, and since that time 1,600 students had entered it, and of those over 800 now occupied positions of more or less importance in the engineering profession. He came there that day to express not only his own personal interest in the school, but that also of the Institution of Civil Engineers, which was by far the greatest engineering institution in the world, was international in character, and comprehended all classes of engineering except the military. Out of the whole body of students trained in the school, no fewer than twenty were now full members of the Institution of Civil Engineers, 175 had become associate members, and 300 had come as students—facts which indicated how fully that institution had recognised the excellence of the training and instruction given in the Crystal Palace School. The Palace Company, in giving to Mr. Wilson, more than thirty years ago, the opportunity of establishing the school, rendered a great service to the cause of technical education. Those who knew what the state of technical education was thirty years ago would agree with him that the Palace directors did then a very remarkable thing in founding the school; they followed up primary education with a good system of secondary education having special reference to engineering, and the excellent results of their action were apparent. The true ideal of engineers was to make their profession a means of advancing the peace, progress, and happiness of humanity by carrying out those great works that brought the peoples of the world into closer contact with one another. That was an ideal worthy of any man's devotion; but the students must bear in mind that it could not be realised without the possession of high scientific knowledge and thorough training. In the Palace School, he was glad to say, practice and theory both had their due recognition, and that was the right foundation for an engineer training, since no training could be effective which did not combine the two.

Transvaal Technical Institute.

A very noteworthy circumstance in the history of South Africa has been the formal opening of the Transvaal Technical Institute. This, according to the *Times* correspondent, is intended to be the nucleus of the future University which, in the opinion of the commission appointed by the Government to gauge the needs of the community in the matter of technical education, will ultimately be found necessary for the Transvaal. The commission, however, rightly decided to make an immediate start.

The Institute, as now inaugurated, has absorbed the Kimberley School of Mines, which for eight years has covered the third and fourth years' courses prescribed by the Cape University for obtaining a degree in this subject. A course in general engineering has been added to enable students to put in their whole time here, while evening classes for others will shortly be begun. In view of the exceptional opportunities afforded at Johannesburg for mining engineering, arrangements are on foot to enable students of the Royal College of Science and other home institutions to proceed to the Transvaal for a year's post-graduate study. It is understood that several mining houses will offer positions in connection with the mines to such students at a small salary.

The question of the development of the institute is occupying the attention of Professor Hele Shaw, the organiser, and of the Council for Technical Education, which is representative not only of the technical scientific bodies but of the whole community. This council, on which devolves the decision regarding the permanent housing of the institute, may be trusted to approach the question with professional knowledge, while it will be at the same time in close touch with the wishes of the people of the Transvaal. In the meantime, the institute has begun its work in the former Boys' High School, and will continue to occupy temporary premises until such time as it is possible to erect permanent buildings on a scale worthy of the cause and of the colony.

Are We Going Too Fast with Scientific Education?

Dr. A. B. W. Kennedy, who gave the toast, "Scientific Education," at the annual dinner of the Institution of Mechanical Engineers, commented upon the progress which the scientific teaching of engineers had made during the past thirty years. In 1874, he said, there was in London hardly a single complete engineering course of any kind; now, no important town in the country felt that its educational system was complete unless it included a full engineering course. He was not sure that we were free from the danger of going a little too fast in the matter of scientific education, so far as their profession was concerned. They would never get the scientific side of engineering properly dealt with unless their teachers could be persuaded that science was not an end in itself, but a means to an end. Sir Edward Fry, who proposed the toas of "The Institution of Mechanical Engineers," re marked that the Institution was founded in 1847, and at the close of last year, the membership numbered upwards of 4,100.

NOTABLE BRITISH PAPERS.

A Monthly Review of the leading Papers read before the various Engineering and Technical Institutions of Great Britain.

THE UTILISATION OF BLAST-FURNACE SLAG.

AT a recent meeting of the West of Scotland Iron and Steel Institute, Mr. E. R. Sutcliffe read an instructive paper, on the "Utilisation of Blast-Furnace Slag." He remarked that the utilisation of waste was receiving great attention in all branches of business. In no other manufacture was there such a vast quantity of waste as in the smelting of iron, and there was no doubt that in future the utilisation of this material would form a most profitable adjunct to that of the manufacture of iron. Great strides have already been made in this direction in France, Belgium, and Germany.

In this country, said the author, very little is being done. Certainly slag is being used to make paving flags, bricks, and cement to a small extent; but practically, beyond what is used for ballast purposes and general concreting and foundations, very little is utilised. The various works which have been erected for utilising slag have demonstrated that slag cement, Portland cement, paving bricks, building bricks, paving flags, and tiles of an excellent character may be made from slag; but in this country we must turn our attention chiefly to the manufacture of Portland cement, building bricks, paving flags, and tiles. Slag cement made by grinding together dried granulated slag and hydrated lime, will not probably be made in this country to any extent—very few slags being suitable for treatment in this way, whereas Portland cement may be made from most slags. And when it is considered that the chief cost in Portland cement mannfacture is in power and fuel burning, and that most ironworks do not know how to utilise their heat to good account, there must be a big future before this method of utilisation, At present where Portland cement is made from slag the cement is clinkered by either coke or coal, and only the power is generated from the furnace gases; the difficulty being in getting a sufficiently high temperature (1,400 degs. to 1,500 degs. C.) with the furnace-gases to clinker the cement. This, however, is a difficulty which no doubt will shortly be surmounted.

BUILDING-BRICKS.

Building-bricks from slag at present are principally made from granulated slag; the method adopted being to intimately mix with the slag from 6 to 10 per cent. of slag cement, hydraulic lime, or Portland cement. This mixture is then moulded into bricks under pressure; the pressure exerted on each brick being from 50 to 100 tons. The bricks are then stacked in the open air, where they are allowed to stand for three months to harden. In wet weather they must be kept under cover for the first few days before exposure; and in cold weather they require protection from the frost for the first few days. This method is the one chiefly adopted in France, Belgium and Germany, where the bricks seem to find great favour. They are of excellent quality, and well adapted for foundation work, but are somewhat porous in character. The plant required is of the simplest character; being confined simply to the mixing machinery and brick-making machine.

ARTIFICIAL PAVING FLAGS.

Concrete paving slabs are now largely used, and the demand for them is rapidly increasing. They are much cheaper than natural paving materials, and are less costly in laying. They wear more evenly, and, being homogeneous, do not split and break away like a natural stratified paving material. Blast-furnace slag is a material particularly adapted for being made into concrete, and when suitable slag is used, and reasonable care taken in the manufacture, most excellent paving flags may be made.

Paving flags from slag may be made either from granulated slag or by using crushed slag to which a proportion of Portland cement is added, usually 2, 2½, or 3 of slag to 1 of cement. The mixture is made into a slurry state with water, and pressed under hydraulic pressure in moulds with a perforated bottom over which a filtering medium is placed, 400 to 600 tons total pressure being put on a flag of the size of 2 ft. by 3 ft. The pressure squeezes the excess water out of the mould, leaving the slab comparatively dry and hard. On removal from the machine, the slabs are allowed to stand on receiving boards for about three days, after which period they are stacked in the open air, six months being required to effect the final hardening. In dry weather the flags should be watered occasionally, or, better still, immersed in water for a few weeks.

This method is the one generally adopted also for making paving flags from granite chips, destructor clinker, and other materials. Some excellent flags are made by hand from these materials and from crushed slag, the material being mixed like ordinary concrete and then pressed into moulds laid on the floor, the top face being smoothed with the trowel. In such cases the flags are kept in the moulds on the floor for a few days before stacking on edge in the open air.

In the author's opinion, however, hand-made flags are not equal to hydraulic pressed flags. They always contain air spaces, never found in a well pressed flag.

RECENT DEVELOPMENTS IN CARGO AND INTERMEDIATE STEAMERS.

AT the ordinary meeting of the Institution of Civil Engineers, on Tuesday, the 12th ult., Sir William H. White, K.C.B., President, in the chair, a paper on "Recent Developments in Cargo and Intermediate Steamers," was read by E. W. De Rusett, M.Inst.C.E. The paper covers more particularly the period since 1899, in which year the author presented a brief note on the subject to the Engineering Conference. The following is an abstract :—

TYPE.

The "shelter decker" is still in favour for special service, and the design of the "single decker" has developed in the production of holds clear of beams and pillars, having a great advantage, especially in the carrying of such cargoes as coal, grain, etc. Tank vessels adapted not only for conveying oil in bulk but also for carrying ordinary cargoes are now largely used. The demands of the fruit-carrying trade have brought forth a special class of steamer fitted with refrigerating plants, and, notably, those trading to the West Indies, are very successful.

SIZE.

Here depth of water in ports, docking facilities, etc., control development, but, nevertheless, great advance has been made. The ships of over 3,000

tons register under construction in the periods 1896-99 and 1900-1903 numbered 718, and indicate a marked increase in size, especially from 7,000 tons and upwards. British superiority in the matter of shipbuilding is remarkable, in spite of keen competition. During the last four years, in the matter of large ships, the British numerical output increased 37 per cent., tonnage 59 per cent., and average size 16 per cent. on the previous four years. America and Germany have developed the shipbuilding industry immensely of late years.

CONSTRUCTION.

The few features noticeable about five years ago are still largely in evidence, such as the flanging of internal work, joggling of frame bottoms, and girder framing, whilst the stiffening of water-tight bulkheads is more rationally arranged. Continuous hatch-coamings, not extended below the deck level, have been introduced. The flanging of the tank side to the shell and the extension of it up the bilge past the level of the bilge keel, has been an improvement. In one case, the practice usual in men-of-war has been followed, the tank side being extended to the lower hold-stringer, resulting in more space for water-ballast and in increased safety.

CAPACITY.

Vessels of 12,200 tons dead-weight and a measurement capacity of about 20,000 tons, at 40 cubic feet per ton, have been very successful. These carry passengers as well as cargo, and have proved exceptionally comfortable. An interesting cargo manifest of a large intermediate liner, appended to the paper, shows 231,300 items and a weight of 9,260 tons. Another vessel carried 39,433 barrels of apples, weighing 2,960 tons, besides 71,000 bushels of wheat, and other miscellaneous cargo. Colliers of 7,000 tons, ore-carriers of 10,000, and "tankers" of even greater capacity indicate great industrial activity and progress.

CARGO APPLIANCES.

Speedy loading and unloading is of the utmost importance, and therefore special attention has been paid to this matter. Winches are more numerous and are run at higher speeds, manilla and small steel-wire runners are used; more derricks are fitted; and the hatchways are larger. Steel hatch-covers, hinged to coamings with patent fastenings, are now used, and do away with the beams.

As an example of what a modern cargo-steamer can accomplish, mention is made of a vessel of 6,000 tons dead-weight, which made 36 voyages of some 55,000 miles in 11 months and 19 days, loading, carrying, and discharging a total of 210,600 tons.

The "turret" class have been markedly successful. One vessel, the "Grängesberg," with twelve large hatchways and twenty-four derricks, worked by twelve double-ended winches, has discharged 10,000 tons of ore in 35 hours. Temperley transporters are largely used, but without grabs. There is ample room for suitable electric winches for this class of work.

BALLASTING.

Increasing need for making half the passages in ballast and bunkers only have called for more attention to ballast-tanks. The adoption of high-wing-tanks for about half-length amidships, has been tried with success, giving a metacentric height of 3 ft. 9 in. in one case. Similar has been the result of McGlashan's system of making a double skin as high as the upper deck, for about half the vessel's length amidships. The plan of carrying the water in special 'tween-deck tanks demands the increase of scantlings, which somewhat diminishes the advantages, but this is less costly than the building of deep tanks. Deep tanks in addition to a double bottom is the usual arrangement, but is only suitable for vessels making long voyages. Some boats with longitudinal centre-line bulk-heads omitted in tanks of 27 ft., holding 1,400 to 1,500 tons of water, have been very satisfactory, being able to discharge this huge volume of water in about five hours. Careful distribution of weights has reduced the strain to a minimum.

ECONOMY OF WORKING.

The design of a vessel vitally affects the consumption of fuel. Vessels of 20,500 tons, making 15½ knots, on a consumption of 140 tons of coal per day; of 19,000 tons, at 15 knots, on 115 tons; of 11,600 tons, at 11·35 knots, on about 46 tons, are a few instances of what has been accomplished in the way of economical running. Careful comparison of the costs of land and sea conveyance gives remarkable results. In fact, taking 1·54d. per ton per geographical mile as the cost of carriage by mineral train in this country, it is found that the inclusive expenses incurred when sea-borne is only about $\frac{1}{35}$ of this figure. The passenger traffic yields figures scarcely less striking. A transatlantic passage, *including* board, costs ·44d. per mile; the accommodation for the third class being luxurious as compared with that of a few years ago. Liquid fuel does not seem on the whole to be making headway, a fact which appears to be largely due to the existing monopolies in this valuable product.

THE ENGINEER'S SIDE OF THE SEWAGE QUESTION.

A PAPER on the "Latest Practice in Sewage Disposal," contributed by Mr. Henry C. H. Shenton to the Society of Engineers, laid emphasis on the practical or engineer's side of the question.

SYSTEMS IN VOGUE.

The author first pointed out that the practical engineering side of the question of sewage disposal as distinguished from the theoretical side had not received the attention it deserved in papers read on the subject. He then briefly reviewed the present methods of sewage disposal in the following order: Natural and artificial precipitation; upward filtration, and the septic tank system, all for the removal of sludge. Broad irrigation, lateral filtration, and downward filtration, on land. The fine filter; the washed-out filter; the contact bed; and the continuously aerating filter. He stated that a careful examination of existing works throughout the country led him to the conclusion that each and all of the foregoing systems had their uses, and produced good results in certain cases. The biological methods, he said, included every recognised system of final sewage purification.

SEPTIC TANKS.

Mr. Shenton is of opinion that the septic tank needs most consideration as regards the methods for the first stage of sewage purification. The best methods of precipitation have been well thought out long ago, and are not generally economical or so suitable for ordinary works. The septic tank s used as a preliminary for land treatment, for filters, or contact beds, or for continuously aerating filters.

and has to a great extent replaced the older methods, being more economical and a much better preliminary for the aerobic action to follow. There is not the slightest doubt, whatever prejudice one may at first have had against the septic tank, that it is practically a most useful, and even indispensable, part of the greater number of the smaller sewage works recently constructed.

In the author's opinion, the dimensions and details of construction of the septic tank need careful consideration by the engineer. At most places the depth does not exceed 7 ft., but the author is of opinion that it is possible that the depth of 7 ft. might be increased with advantage. It is very evident to him that 7 ft. is near the minimum depth for a septic tank, especially if that tank is only lightly covered.

A HOPELESS ARRANGEMENT.

Perhaps the most general practice at sewage disposal works has been to turn the old chemical precipitation tank into a septic tank; such a tank is often 5 ft. deep at the inlet end, and 4 ft. 6 in. deep at the outlet end. The first thing done has been to simply let the sewage run through it without any scum board or trapped outlet. Any amount of solid matter has come out with the effluent, but a great deal has been liquefied also by the septic action, with the result that the amateur engineers of the district have been much pleased at the successful application of theoretical principles, and that a certain definite saving has been effected by getting rid of the sludge difficulty. The contact beds or filters, however, have later on become clogged, and the contact bed principle has been severely blamed in consequence. Later on the septic tank—or so-called—has been found to be sludged up, and has had to be emptied, and the district councillors of the place where such occurs will tell you that engineers have still a great deal to learn on the subject of sewage disposal.

IMPORTANT POINTS IN SEPTIC TANK WORK.

In the course of further remarks, Mr. Shenton said he considered the best form of tank, under ordinary conditions, was one covered with a light roof. It should not be necessary to empty the septic tank often. Still, another important point in septic tank work was mentioned by the author. Again and again, he remarked, one sees works designed with a storm water overflow coming out of the septic tank; this is surely a mistake. Storm water, up to three times the dry weather flow or more, may well flow through the tank on to the beds, but when the limit is reached at which the overflow comes into action, there can be no possible advantage in taking clean water into the septic tank in order to let it overflow. Obviously, the common-sense method is to let it overflow out of the sewer before reaching the septic tank.

The following is from the author's concluding remarks :—

Great scientific authorities appear to differ so strongly on the subject of sewage disposal, that the general public regard the whole question as being in a chaotic state, and this feeling is not removed by the very cautious statements made by the Royal Commission, or by their slowness to express any definite opinion. These differences are surely more of a theoretical than of a practical nature. No doubt we go on learning, but we are no longer in the experimental stage, and we know perfectly well that money spent by local authorities in putting in proper works will not be wasted.

The author feels confident that scientists will agree with him in saying that good engineering and careful attention to the details of construction of new works are absolutely essential if the discoveries of scientists, and the principles laid down, are to have fair play, and that they will welcome a discussion of the purely engineering side of the question, which cannot fail to be of interest alike to the practical and to the theoretical man.

HEATING AND VENTILATING SMALL WORKSHOPS.

At the meeting of the Junior Institution of Engineers, held at the Westminster Palace Hotel, on April 8th, the Chairman, Mr. Samuel Cutler, Junr., M.I.Mech.E., presiding, a paper on "Heating and Ventilating Small Workshops," was read by Mr. Kenneth Gray, M.San.Inst. Employers of labour, he said, are beginning to pay attention to the ventilation and warming of their shops. Experience shows that, apart from the benefit which the employees derive from healthy and comfortable surroundings, a real economy is effected where a large quantity of fresh, warmed air is continually passing through the shops. The breathing of impure air, charged to excess with carbonic acid, and laden with all kinds of animal, vegetable, and mineral impurities, greatly reduces the bodily vigour of the workpeople, and so contributes to slackness.

A close investigation of the changes which take place in air in the process of breathing seems to show that expired breath, although at the moment of leaving the lungs, no doubt tends to rise, yet is probably rapidly cooled, and, being a heavier mixture than fresh air, falls again almost at once. The fact that air at 32° F. is raised through 60° F., although in contact with the lungs for but two or three seconds, shows how rapidly its temperature is changed. And as in breathing out, it is emitted through the nostrils in a downward direction, in two attenuated streams, it seems probable that an equally rapid cooling takes place. Under these circumstances, if the ventilating outlet registers are placed near the floor level, and the fresh air inlets above head level, and some mechanical power is used to drive the air into the shops, a continual stream of fresh air will be passing into the building, while the expired vitiated air is safely carried away through the extraction shafts.

With all systems of ventilation it is necessary to provide means to warm the incoming air, and it seems advisable to do this while it is passing through the main duct leading to the shops. But it is a good plan not to heat the air to a high temperature; there are many reasons why it is advisable to heat it only to the same temperature as that which it is intended to maintain in the shops. The warming of the shops can best be secured by direct heating, *i.e.*, the fixing of the radiating surface inside the various shops. Where appearance is not of such importance as economy of space, this can be effectively done by fixing hot-water or steam pipes above head level. The only difference this makes in warming a building is that it takes rather longer to raise the temperature than when the pipes are fixed on the floor level; but as soon as the required temperature is reached it can be just as easily maintained.

Messrs. W. G. Wernham, Percy Young, J. H. Pearson, A. W. Marshall, T. C. Morewood, R. Marshall, G. T. Bullock, G. C. Allingham, J. N. Boot, J. W. Nisbet, and the Chairman took part in the discussion which followed, and much interest was shown in the relative

merits of mechanical and natural ventilation, and the Plenum and Extractum systems. The next meeting of the Institution takes place on May 6th, when a paper on "The Design of a Dry Dock" will be read by Mr. A. W. Young (Member) of the Admiralty Works Department.

TECHNICAL EDUCATION AT HOME AND ABROAD.

(*Concluded.*)

TECHNICAL EDUCATION ABROAD.

WITH regard to the manner in which technical education has been viewed and treated in other countries, it may be noted that, in most Continental States, with perhaps the exception of Germany and France, theoretical knowledge has been *too much* in evidence, and while the student of engineering has been well equipped with a large amount of theoretical knowledge, he has very often had little or no practical experience of the machines or designs he has been studying. This state of things is to be deplored, and it is very satisfactory to find now on the Continent as at home, a tendency to the general adoption of laboratories and workshops in all the technical institutions to supplement the lectures.

The Engineering Congress held in Paris, 1899, was very unanimous in its opinion of the absolute need of well-equipped laboratories of technical instruction.

GERMANY.

Of the European States Germany perhaps holds a leading position with regard to the development of the education of engineers. One good point in the system there in vogue is that a student must have had *some* practical experience before he may enter for his first academic examination.

FRANCE.

In France the spirit of development in educational matters has also been very much alive, and schemes by which it has been sought to bring about improvements have been adopted. One such scheme* may be cited here.

In 1882 a school in connection with the Northern Railway of France was founded exclusively for the benefit of the sons of the employees.

Entrance is obtained by competitive examinations held every year under the supervision of the chief engineer. The number of pupils average forty, they enter at from thirteen to fifteen years of age, and take a course of tuition extending over three years. There are no fees and all books and tools are supplied. The subjects taught are: Arithmetic, geometry, geography, French language, physics and chemistry, engine construction and drawing, with a practical training in locomotive work. Periodic examinations are held upon the results of which prizes and certificates are awarded.

Up to the present, about two-thirds of the pupils have been awarded certificates, and have mostly entered the company's service. Some have gone into the employment of other firms, but these have always the privilege of preference over all other candidates should they afterwards wish to re-enter the service of the company.

* "Revue Générale des Chemins de fer," July, 1900.

AMERICA.

In America this subject has received very full attention, and the author thinks that a great deal of the means adopted in the United States could be profitably studied in this country. For some thirty years America has been working out the higher education of engineers, and there is sufficient testimony in her well-equipped colleges that a long-felt want has been supplied.

At Cornell University, for example, there is accommodation for some 2,000 students, who enter on passing an entrance examination of no great difficulty, and continue their studies for four or five years. On leaving at about 22 or 23 years of age, a student is considered to have so developed in his practical and theoretical experience as to be capable of taking the reins of management of not unimportant works.

With reference to the system in vogue in foreign countries there is one very important factor, viz., that the required training may be obtained with much lower fees and less expenditure generally to the student than in Great Britain; which doubtless has had the effect of sending so many British students abroad—especially to Germany—to pass through a course of study for which in this country their means would have been quite inadequate.

SCOTLAND.

In Scotland, however, a more liberal view of this question has been taken than in England; there, a student is able to take a full course for what at the best colleges in England would hardly suffice for one session, and with the additional advantage that in the long vacation, during the summer months, he is usually able—due to the courtesy of the employer—to follow his profession in the shipyards, shops, or drawing office.

There is at the moment a general tendency on all sides to what may be termed a second revival of learning, and it is hoped the present movement may break through that conservatism by which progress—at least in technical matters—has been so long retarded.

COMING EVENTS—MAY.

2nd.—Society of Engineers meet at 7.30 p.m. Cantor Lecture at the Society of Arts.

5th.—The Iron and Steel Institute: Annual Meeting. —Civil and Mechanical Engineers: Society meet at Caxton Hall at 8 p.m.

6th.—The Iron and Steel Institute: Annual Meeting.

7th.—Birmingham Association of Mechanical Engineers.

9th.—Institution of Mechanical Engineers: Graduates' meeting at 7.30 p.m. Cantor Lecture, Society of Arts.

11th.—Birmingham Local Section Institution Electrical Engineers: Visit the University Power Station, followed by Annual General Meeting.

12th.—Institution of Electrical Engineers meet.

14th.—Birmingham Association of Mechanical Engineers: Visit the University Power Station.

16th.—North-East Coast Institution of Engineers and Shipbuilders: Graduates' Section meets at Newcastle.

18th.—North-East Coast Institution of Engineers and Shipbuilders meet.

19th.—Institution of Mining and Metallurgy, 8 p.m.

20th.—City of London College Science Society: Annual Meeting at 7.30 p.m.

22nd.—The International Marine Association: Fourth Congress opens in Lisbon.

24th.—Birmingham University Engineering Society.

26th.—The Leeds Association of Engineers meet at 7.30 p.m.—Institution of Electrical Engineers: Annual General Meeting.

27th.—The Midland Counties Institution of Engineers: "Federated" Meeting.

28th.—The International Marine Association: Fourth Congress closes in Lisbon.

BOOKS OF THE MONTH.

"A MANUAL OF CIVIL ENGINEERING."

By William John Macquorn Rankine, C.E. With numerous diagrams. Charles Griffin and Co., Ltd. 16s.

Professor Rankine's indispensable manual has now reached its twenty-second edition, which has been thoroughly revised by Mr. W. J. Millar, C.E., and has received a number of additions. It is almost unnecessary to remind engineers that, like ancient Gaul, it is divided into three parts, the first dealing with engineering geodesy, or field-work; the second with materials and structures; and the third setting forth under the heading of combined structures, the principles according to which the structures described in the second part are combined into extensive works of engineering, such as roads, railways, river improvements, water-works, canals, sea defences, harbours, etc. In its latest form the volume has 820 pages and about 300 figures.

"PRACTICAL SHIPBUILDING."

A Treatise on the Structural Design and Building of Modern Steel Vessels, the Work of Construction, from the Making of the Raw Material to the Equipped Vessel, including Subsequent Up-keep and Repairs. By A. Campbell Holms. In two volumes. Longmans, Green and Co. 48s. net.

Mr. Holms has done an important service by presenting a complete view of practical shipbuilding in such a manner that it is equally valuable for systematic study or casual reference. While carefully avoiding abstruse problems, he describes succinctly the fundamental theories covering structural design, and here it may be said that in conjunction with the plates which are issued in a separate volume, the subject matter throughout the work can be understood by any intelligent reader. The author then discusses the various stresses to which the hull is exposed, their straining tendency, and the different structural designs by which the necessary strength to resist them may be secured. Each important part of the hull is then considered from three points of view, viz., its purpose in the structure and the particular stresses and straining effects to which it is liable; the various formations adopted in its design, with the rules governing them as regards scantlings and strength; and a description of the actual work of making it in the shipyard and fitting it in the ship. Attention has been given to almost every point that is likely to arise in modern practice, valuable chapters being included on corrosion, launching, etc., and on the work of the drawing office.

"THE 'SHIPPING WORLD' YEAR-BOOK."

A Desk Manual in Trade, Commerce, and Navigation. Edited by Evan Rowland Jones. 1904. Published at the "Shipping World" Office. 5s. in United Kingdom; 6s. in foreign countries.

Our old friend the "'Shipping World' Year Book"—edited by Mr. Evan Rowland Jones—makes its appearance this year with a new map specially prepared by Mr. J. G. Bartholomew, F.R.G.S., showing the Routes of Steamers and Railways throughout the World, with the East Bound and West Bound "Lanes" across the Atlantic, and the Products, Ports, Coaling Stations, Coalfields, etc., of all Countries and Colonies. The inset maps show many of the great shipping centres and waterways of the world.

The additions made in the present edition of the "Year Book" embrace: The New Tariffs of the South African Customs Union, Australia, China, Japan; Turkey, the Philippines, Venezuela, and other countries the separation of foreign Tariffs formerly embraced in the composite section; and the correction of all; the new Admiralty Regulations for the training of Naval Officers; a list of the Customs Boarding Stations; New Board of Trade Rules governing Shelter-decked Steamers, Deck Cargoes, Certificates of Discharge and Character, Naturalisation, etc.; Customs regulations governing the Export (Coal) Duty Act, 1901, and a Table giving the Steam Tonnage of all nations of twelve knots and upwards. In this eighteenth edition are also included: the Amendment Act of August 6th, 1900, giving the reciprocal obligations of dock, canal, and harbour authorities on the one hand and shipowners on the other; the International Code of Signals (illustrated); returns for the year ended December 31st, 1903, of Vessels built and building for the World's Navies, of the output of British, Colonial, and Foreign merchantmen, of the World's Tonnage engaged in the Foreign and Coasting Trades, and of our Imports and Exports; and the addition of every known port not hitherto included in the Port Directories; together with the Board of Trade Regulations governing the loading of turret-deck vessels, and for Preventing Collisions at Sea; the new Departmental Orders governing the Surrender of Deserters Abroad, the Carriage of Grain Act, and all other important Regulations affecting Shipping, now operative. All the regular features have been brought up to date, and the publication well maintains its reputation as a carefully edited and efficient reference work.

"CYANIDING GOLD AND SILVER ORES."

A Practical Treatise on the Cyanide Process; embracing Technical and Commercial Investigations, the Chemistry in Theory and Practice, Methods of working and the Costs, Design and Construction of the Plant and the Costs. By H. Forbes Julian and Edgar Smart, A.M.Inst.C.E. Charles Griffin and Co., Ltd. 21s. net.

This very complete work brings together in a single volume a mass of data which should be invaluable to the engineer. The authors have chiefly concerned themselves with the principles involved in working the process and in the construction of plants. In cyanide practice the importance of a thorough knowledge of theoretical principles is too obvious to need emphasis, and that these are clearly explained will be understood by the readers of Page's Magazine who are already familiar with Mr. Smart's lucid and informing style. The work is of an essentially practical type, in which much attention has been given to the important question of costs. The formulæ and rules are, for the most part, deduced from practice. Constants are used which may be adjusted to meet abnormal conditions, and thus the formulæ can be universally applied. Copious tables are given, as the best means of simplifying calculations and of expressing results for practical men. The working drawings also have been largely used in actual practice. The forty-four chapters comprised in the work are illustrated by 191 figures, including some thirty-five folding plates. The authors are to be congratulated upon the production of what should prove to be a standard work.

"BRITISH RAILWAYS."

Their Organisation and Management. By Hugh Munro Ross, B.A. Edward Arnold. 5s. net.

We recommend this book to the attention of those who are seeking general information about our British Railways; the author does not profess to deal in technicalities. The work is concerned rather with questions of organisation and administration; the author takes us behind the scenes and tells us how things are worked. For instance a time table to the ordinary passenger seems so simple as to require no explanation. The author shows in a most interesting way how the time tables are made up, and how the traffic manager of an ordinary trunk line contrives to make a single pair of rails accommodate trains of all speeds from expresses timed at fifty or fifty-five miles an hour, down to heavy mineral trains travelling at only one quarter that rate. He has also much of interest to say upon such subjects as train miles and ton miles, the carriage of passengers, goods rates, rate legislation of 1891 and 1892, capital, expenses, and dividends. With regard to the future, it is remarked that the railways may fairly regard the prices they paid for fuel in 1900 and 1901 as abnormal; but they need not look forward to any reduction in wages, or to any general increase in their rates for carrying passengers and goods. Their hope must rather lie in greater economy of operation. Not much space is devoted to the subject of electrical conversion, but the author considers that for the present electrical traction for long distance express trains and for heavy goods traffic are scarcely within the range of practical railway politics; and many difficult questions, both financial and engineering, will have to be answered before the steam locomotive finally disappears from our main trunk lines.

"WORK."

The Illustrated Weekly Journal for Mechanics. Vol. XXVI. from August 8th, 1903, to January 30th, 1904. Cassell and Co., Ltd.

Volume XXVI. of "Work" is, as usual, replete with information and drawings interesting to mechanics, the frontispiece being a coloured supplement illustrating a fretsaw for lathe with vertical movement and tilting table. The other coloured supplements are chiefly concerned with the construction of domestic furniture. The index shows a very wide range of subject, from acetylene generators to an ice yacht.

"MODERN ELECTRIC PRACTICE."

Edited by Magnus Maclean, M.A., D.Sc. Vols. I. and II. The Gresham Publishing Co. 9s. net each.

Professor Maclean has gone to work on the assumption that no comprehensive treatise on modern electric practice, suitable alike for students and practical engineers, can be produced by a single writer. He has accordingly sought the aid of more than thirty technical men, each of whom will contribute his specialised share to the six large volumes, which will comprise the work. This co-operation on the part of a number of writers will necessarily involve a certain amount of overlapping, but the author deserves considerable credit for the manner in which, judging by the two volumes which are before us, and the outline of the treatise contained in the first volume, he has welded these contributions into a harmonious whole. The volumes, both as regards illustrations, printing, and cover, have a highly-artistic finish, somewhat rare in technical works.

The treatise will be divided into five sections, as follows: (1) the Measuring, Generating, Transforming, and Storing of Electric Currents; (2) Electric Lighting and Electric Power Distribution; (3) Electric Tramways; (4) Boilers and Prime Movers; (5) Miscellaneous Applications of Electricity. In Volume I. under Section 1—the Measuring, Generating, Transforming, and Storing of Electric Currents—will be found the following contributions: (1) Electric and Magnetic Measurements, by Alfred Hay, D.Sc., M.I.E.E. (2) Alternating-Current Measurements, by E. W. Marchant, D.Sc., M.I.E.E.; (3) Continuous-Current Generators, by W. C. Mountain and J. Leggat; (4) Alternating-Current Gererators, by E. J. Berg; and (5) The Continuous-Current Motor, by A. T. Snell, C.E., A.M.Inst.C.E., M.I.E.E.

Vol. II. has the completion of Section 1, as follows:—(6) Alternating-Current Motors, by M. B. Field, M.I.E.E., A.M.Inst.C.E., and G. G. Braid, A.M.Inst.C.E. (7) Static Transformers and Rotary Converters, by A. F. Berry; and (8) Electric Storage Batteries by J. T. Niblett, M.I.E.E. In this volume the section of Electric Lighting and Power Distribution is commenced, Mr. W. E. Warrilow being responsible for (1) Switches and Switch-Gear, and Mr. J. C. A. Ward. A.M.I.E.E., for (2) Electric Mains.

"WHO'S WHO. 1904."

A. and C. Black. 7s. 6d. net.

If size be a criterion of success, "Who's Who for 1904" has made a marked advance. The tables which formed the first part of this vade mecum of identification have been ousted from the parent book this year, and form a separate work, which has received the name of the "Who's Who Year-Book." 1s. net. Despite this excision, "Who's Who" seems to lose nothing in bulk, and it certainly does not lose in interest. We have on many occasions put "Who's Who" to the practical test, and have often admired the way in which the editor carries out his very difficult task. "Who's Who?" is not an easy question to grapple with, but the volume under consideration answers it in nine cases out of ten with accuracy and efficiency.

From the same publishers we have also received a copy of "The Englishwoman's Year-Book for 1904," which well maintains its standard of usefulness, and has, among other features, a quantity of information on technical education, scholarships, etc.

LOCKWOOD'S BUILDER'S, ARCHITECT'S, CONTRACTOR'S, AND ENGINEER'S PRICE BOOK FOR 1904.

A Comprehensive Handbook of the latest prices of every kind of material and labour in trades connected with building, including many useful memoranda and tables, with a supplement containing the London Building Acts, 1894 and 1898, and other enactments relating to buildings in the Metropolis with the By-laws and other Regulations now in force. Notes of all important decisions in the Superior Courts, and an index to the acts and regulations. Edited by Francis T. W. Miller. Crosby, Lockwood and Son. 4s.

In the 1904 edition, special attention has been given to the distinctive features of modern building—such as sanitary appliances in their latest forms, improved methods of ventilation, lighting, etc.—as well as to new forms of materials. The work generally has been brought up to date and well maintains its reputation as an office auxiliary of the first class.

We are compelled to hold over a number of book notices owing to pressure upon our space.—[Ed.]

OUR DIARY.

March.

22nd.—Launch of the twin-screw steamer *Antrim*.—At a meeting of Leeds citizens it is announced that £39,938 has been subscribed towards the £100,000 which must be raised before the projected university obtains the sanction of the Privy Council.

23rd.—Opening of the spring meeting of the Institution of Naval Architects at the Society of Arts.—It is reported that there will be an increase of over £600,000 in the New Zealand Revenue.

24th.—The Cunard Company decide to adopt turbine engines in the new fast steamships which are to be built under their agreement with the Government.

25th.—The Institution of Naval Architects conclude their spring meeting.

26th.—The G.P.O. announce the extension of telephonic communication between a number of provincial towns in England and France.—A Hyde Park demonstration protests against the importation of indentured Chinese labour into the Transvaal.

28th.—The Lord Mayor formally opens the widened footways of London Bridge.—An initial journey of inspection made over the London United Tramways company's new line from Southall to Uxbridge.

29th.—Opening of the Transvaal Technical Institute—the nucleus of the future university at Johannesburg.—The North-Eastern Railway Company open electric train service on their Newcastle surburban lines.

30th.—Launch at Hebburn-on-Tyne of the *Turbinia*—the first turbine passenger steamer for service on the Canadian lakes.

31st.—Our total revenue receipts for the year ending to-day are £151,212,499.—The Goldsmiths' Company make a subvention of £1,000 to the Royal Society to constitute a radium research fund.—Launch of the twin-screw steamer *Dunluce Castle* at Queen's Island.—The new lighthouse at Dungeness is brought into use.

April.

1st.—The South Australian revenue return for the past nine months amounts to £1,785,850.

2nd.—A meeting of the Northumberland Coal Conciliation Board agrees upon a reduction of 2½ per cent. off the miners' wages.

5th.—It is announced that Lieut.-Colonel R. E. B. Crompton, C.B., has been granted the honorary rank of major on relinquishing his temporary commission for service in South Africa.—Death of Mr. J. S. Forbes, the chairman and director of the London, Chatham and Dover Railway.

6th.—Lord Kelvin is elected Chancellor of the Glasgow University.

7th.—The trustees of the Swansea Harbour accept the tender of Messrs. Topham, Jones and Railton, Westminster, for the construction of new docks.

8th.—The document embodying the Anglo-French Agreement is signed at the Foreign Office by representatives of the two Governments.

9th.—The New Zealand Annual Congress of Trade Council delegates resolve to urge the Government to establish ironworks and shipbuilding yards, and to nationalise the marine, coastal, and inter-colonial services.

10th.—Death of Colonel John Stevenson.

11th.—A representative conference of miners of the United Kingdom meet under the presidency of Mr. Enoch Edwards to appoint a deputation to the Chancellor of the Exchequer with a view to the abolition of the coal tax.

12th.—Issue of a Parliamentary paper containing the text of the Agreement between Great Britain and France.—Publication of Lord Cromer's annual report on the condition of Egypt and the Soudan.—The Chancellor of the Exchequer receives a deputation of coal-owners, exporters, miners, etc., who urge the repeal of the export duty on coal.—Telephone service opens between provincial towns in England and France.

14th.—Counsel on behalf of the City Corporation formally intimates the withdrawal of the Bill for the reconstruction of Southwark Bridge.

15th.—A Parliamentary committee rejects the East London and Lower Thames Electric Power Bill.

18th.—Submarine A1, which was sunk by collision a month ago, is successfully raised and docked.—The *Times* Johannesburg correspondent deprecates further delay in putting the Labour Ordinance into effect as being prejudicial to the mining industry and probably causing difficulties in the Chinese recruiting districts.

19th.—Death of Sir Clement Le Neve Foster.—Launch at Barrow of the *Sentinel*, the first war vessel of the new *Scout* class.—Launch of a steamer for direct West Indian service at Govan.—A destructive fire breaks out at Toronto.

20th.—Sir W. White and others interested in the production of steel visit Hadfield's Steel Foundry, Sheffield.—The Toronto fire is subdued—property destroyed covered an area of 30,000 acres; the total loss is estimated at £2,000,000.

NEW CATALOGUES AND TRADE PUBLICATIONS.

Simplex Steel Conduit Company, Ltd., send an embossed trade mark show card. It is a bold and striking design suitable for hanging on the wall.

Alfred Dodman and Co., Ltd., forward a picture post-card, showing a consignment of their Cornish boilers leaving for South Africa, January 6th, 1904.

Allgemeine Elektricitats - Gesellschaft und Union-Elektricitats-Gesellschaft.—An interesting pamphlet on electric locomotives, in which full advantage is taken of the best half-tone work.

Walker Bros., Ltd., Victoria Iron Works, Walsall, are issuing a series of large postcards with details of their specialities. The one before us gives a complete list of rolled steel joists.

The Lahmeyer Electrical Company, Ltd.—List No. 13 B gives full details of their controllers and other apparatus employed for electrically-driven cranes, hoists, lifts, and other variable speed machines.

The British Thomson-Houston Company, Ltd.—Pamphlets Nos. 165 and 166 deal respectively with open arc lamps and electro-magnetic track brakes, and are perforated ready for filing on the firm's cumulative catalogue.

Bath Electric Manufacturing Company, Ltd., forward Pamphlet No. 15, descriptive of their "Kramos" Resistance Piece, which is described as an electro-ceramic product, quite original in its composition, structure and methods of production.

The Anglo-American Machine Tool Company, Ltd.—From this firm we have received an engineer's sketching-pad for making drawings to scale. The price is stated at 6d. net, but as the specialities of the firm are largely in evidence, we presume that this is nominal only. It is neatly produced and should find a wide use.

The Metallic Paint Company, Ltd., of Cardiff, send us a sample of their Moreton's E.G. solution—a metallic paint for coating iron and woodwork, also cylinder tops and engine-room fittings, etc. It is claimed for this paint that it is unaffected by heat (up to 400 deg. F.), salt water spray, atmospheric or climatic conditions. The tint is a bright silver.

S. Howes and Co. (L. E. Barbeau, President).—The list of wheat and seed cleaning apparatus, issued January, 1904, supersedes all previous issues. We are reminded that catalogues are furnished in French, Spanish, German, Italian or English, upon application, for agricultural, bakers', barley, blacksmiths', canning, coffee, confectionery, corn (maize) milling, cotton, flour mill, malt, oatmeal, rice, seed, and wheat cleaning machinery, rams, pumps and turbines.

W. H. Willcox and Co., Ltd.—The latest booklet published by this firm illustrates various motor engineers' specialities exhibited at the recent Automobile Exhibition at the Crystal Palace. It is of special interest to motor-car manufacturers and includes details of lubricating oils, semi-rotary water-circulating pumps, Penberthy patent automobile-injectors, X-L water raisers, patent wire-bound hose, "Richardson" boiler feed pump, lubricators, oil cans, lifting jacks, belting, spanners, pliers, tool kits and tools of every description.

Graham, Morton and Co.—From this firm we have received an attractively-printed souvenir of the visit of inspection paid to the new engineering works which have been described in PAGE'S MAGAZINE. H.R.H. the Prince of Wales recently accepted a copy of the souvenir and at the same time congratulated Mr. Maurice Graham, the managing director, on the great rapidity with which the undertaking was carried out. This firm seems to be one of the first to follow the dictum of His Royal Highness, given on September 5th, 1901, that the old country must wake up. The souvenir before us presents a capital object lesson in efficient organisation.

Fleming, Birkby and Goodall, Ltd.—The new catalogue of this firm's specialities is divided as follows: Leather beltings; textile beltings; belt fasteners and stretchers; picking bands, pickers, hydraulic leathers, leather and canvas hose; India rubber goods, hard fibre, gutta percha, ebonite, steam packings, etc.; Gilbert wood pulleys, wrought iron pulleys, metallic tubing, and sundries; card clothing, silk combs, etc. Section H is devoted to useful hints on leather belting, rules, mechanical data, and other special and general information on commercial matters. Everything has obviously been done to make the catalogue complete, and its arrangement leaves nothing to be desired.

The British Westinghouse Electric and Manufacturing Company, Ltd.—Special Publication No. 7,002 (Second Edition), is an interesting account of the Washington, Baltimore and Annapolis Single Phase Railway, by Mr. B. G. Lamme, being a paper presented at the 168th meeting of the American Institute of Electrical Engineers, New York, September 26th, 1902. Special Publication, No. 7,004 (Second Edition), is Mr. N. W. Storer's description of the operation of variable speed D.C. motors on the three-wire system. Another publication received from this company is a reprint of the Report of the Board appointed to inquire into the efficiency of turbine engines; it is reprinted from the "Journal of the American Society of Naval Engineers."

Horsfall Destructor Company, Ltd.—List No. 1 of Horsfall Destructors has a collection of instructive illustrations showing the numerous plants erected by the company at home and abroad, from Accrington to Zurich. Page 85 brings us to the Horsfall Destructor on the Bullerdeich, at Hamburg—the largest destructor in the world. This was erected in 1895, and has thirty-six cells of the Horsfall standard back-to-back top-feed type. At the end of the catalogue will be found details of the Horsfall patent hospital destructor, portable destructor, centrifugal dustcatcher, furnace for recovering solder, clinker railway, clinker crushing mills, and mortar mills, all being specialities of the company. List No. 2 comprises reports and certificates.

Crompton and Co., Ltd.—From this firm we have received a copy of the second edition of their Potentiometer pamphlet, a price list of testing-room appliances, and a brief description of their electrical pyrometers. The Crompton pyrometer is designed for the continuous indication of the temperature of flue gases, of superheated steam, and of similar parts of steam plants, not exceeding 950 deg. F. or 500 deg. C. It has been adopted in many of the principal electric lighting and power stations in England as the standard instrument for verifying apparatus of all kinds, and of measuring the output of the machines and station, and has been supplied to various important technical colleges and laboratories as a part of their equipment.

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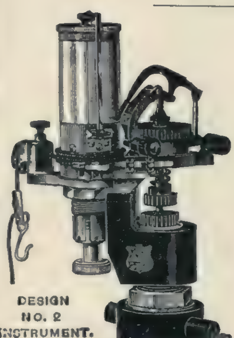

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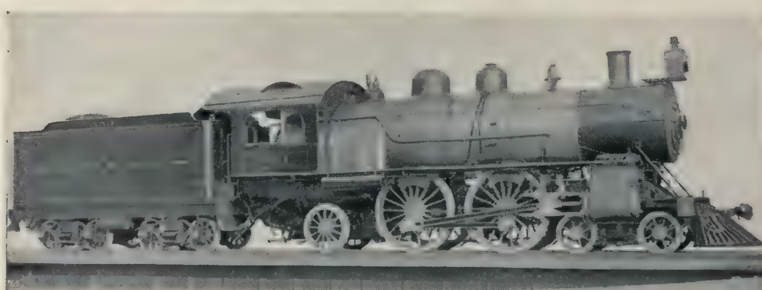

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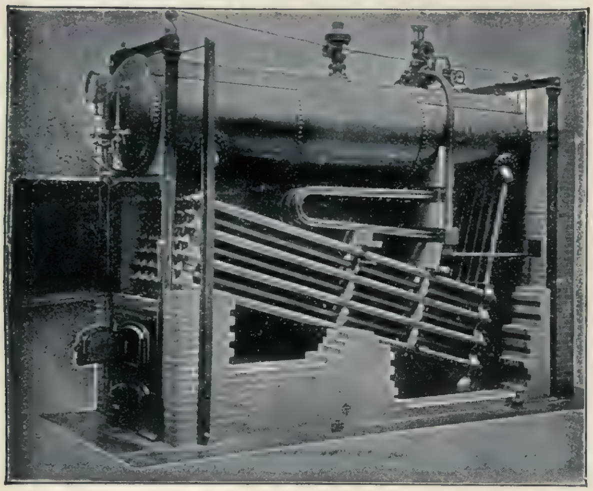

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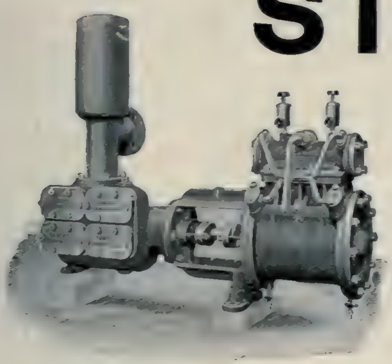

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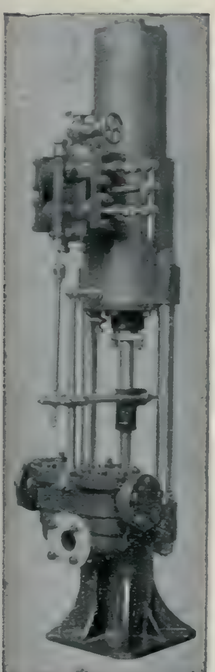

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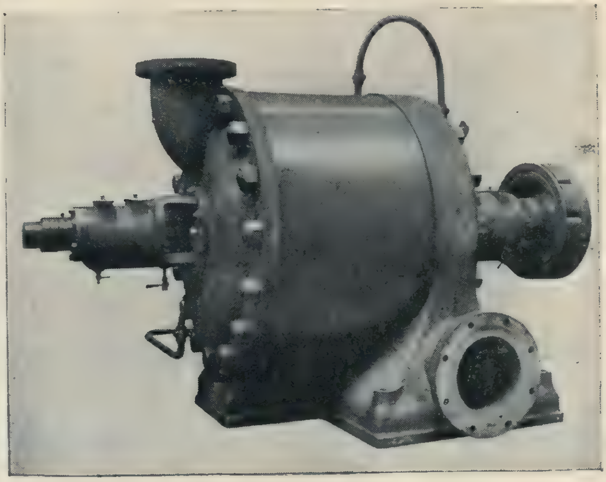

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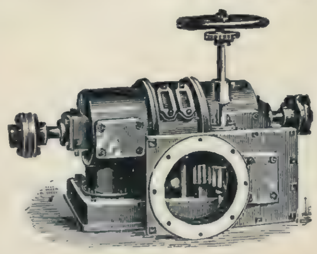

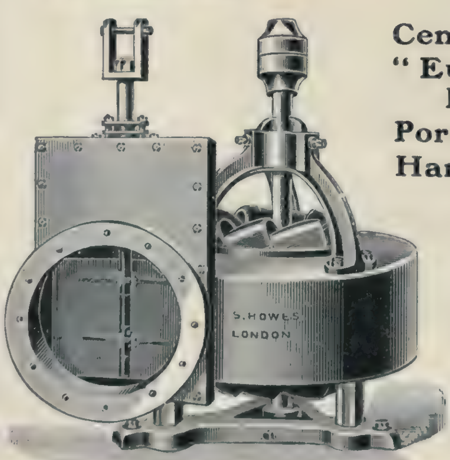

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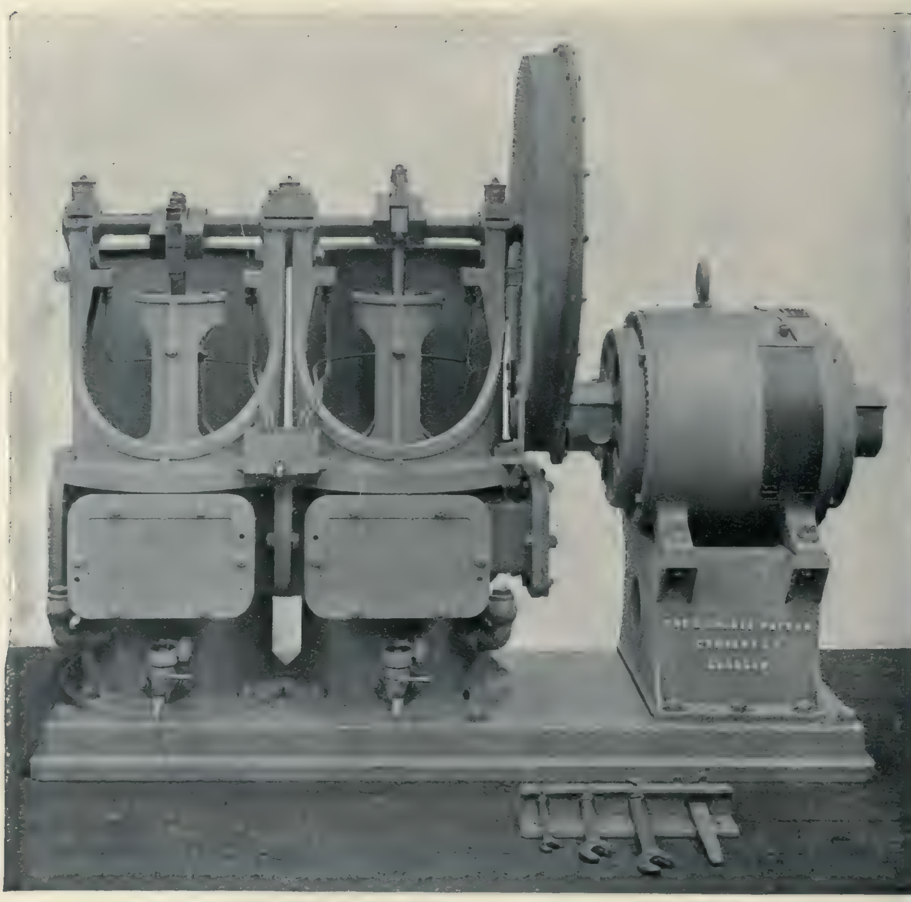

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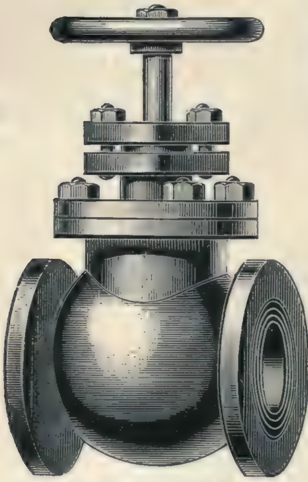

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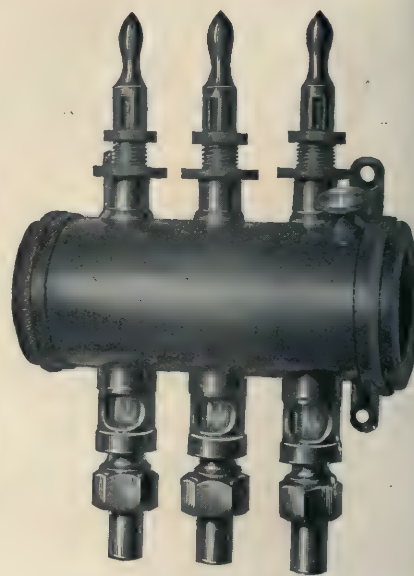

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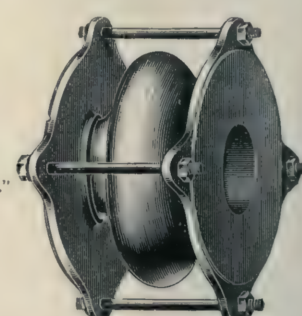

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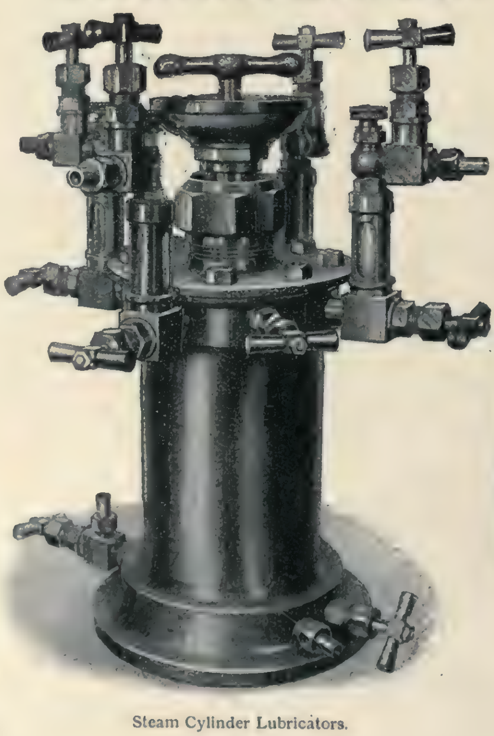

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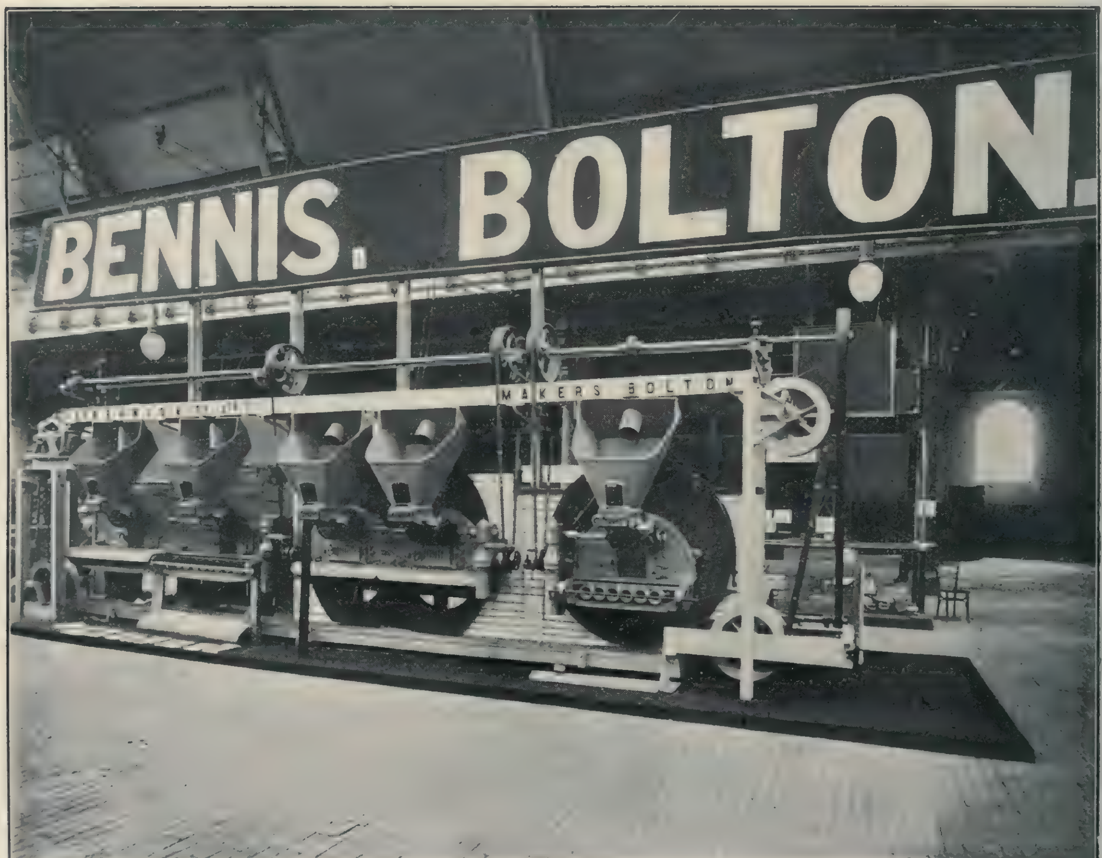

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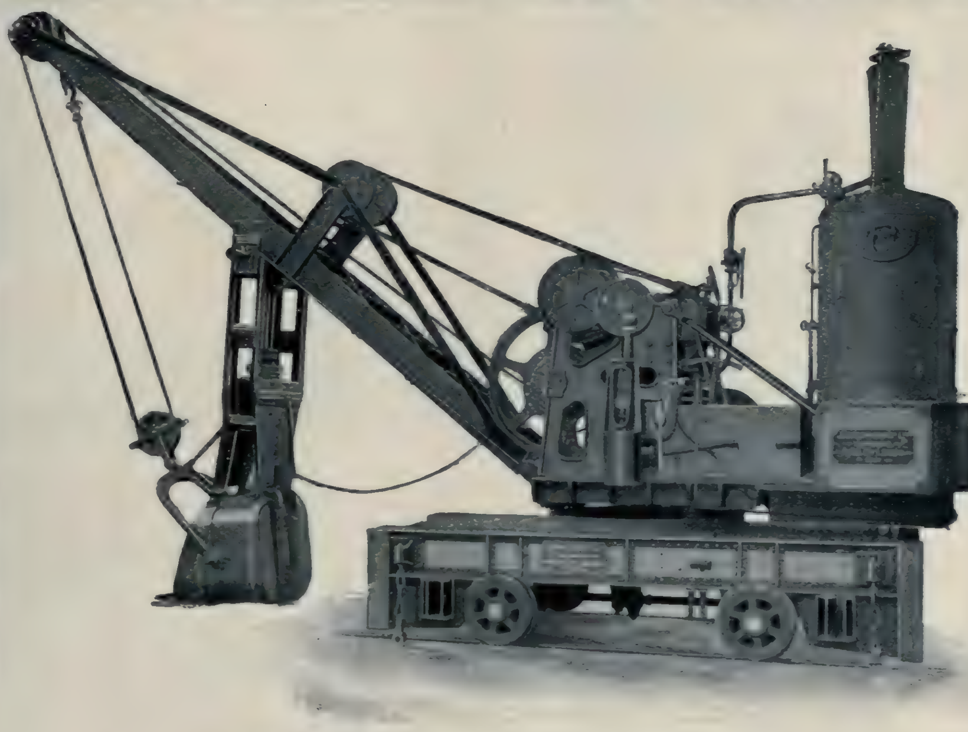

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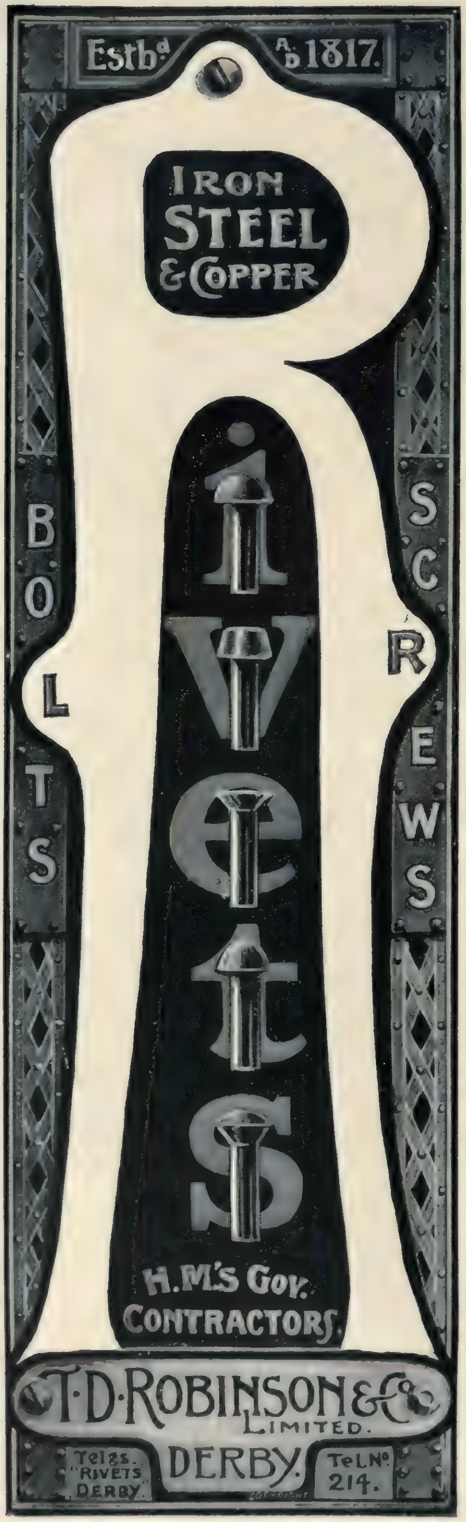
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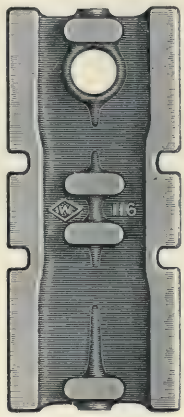

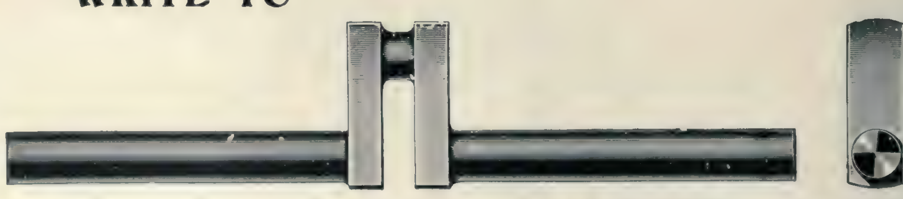

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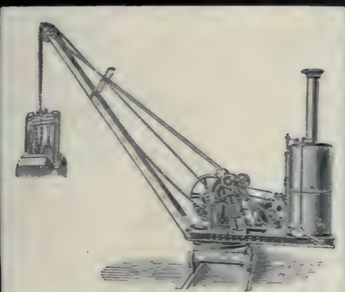

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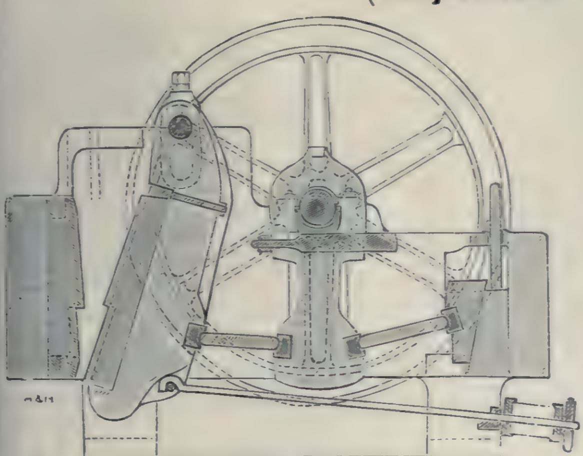

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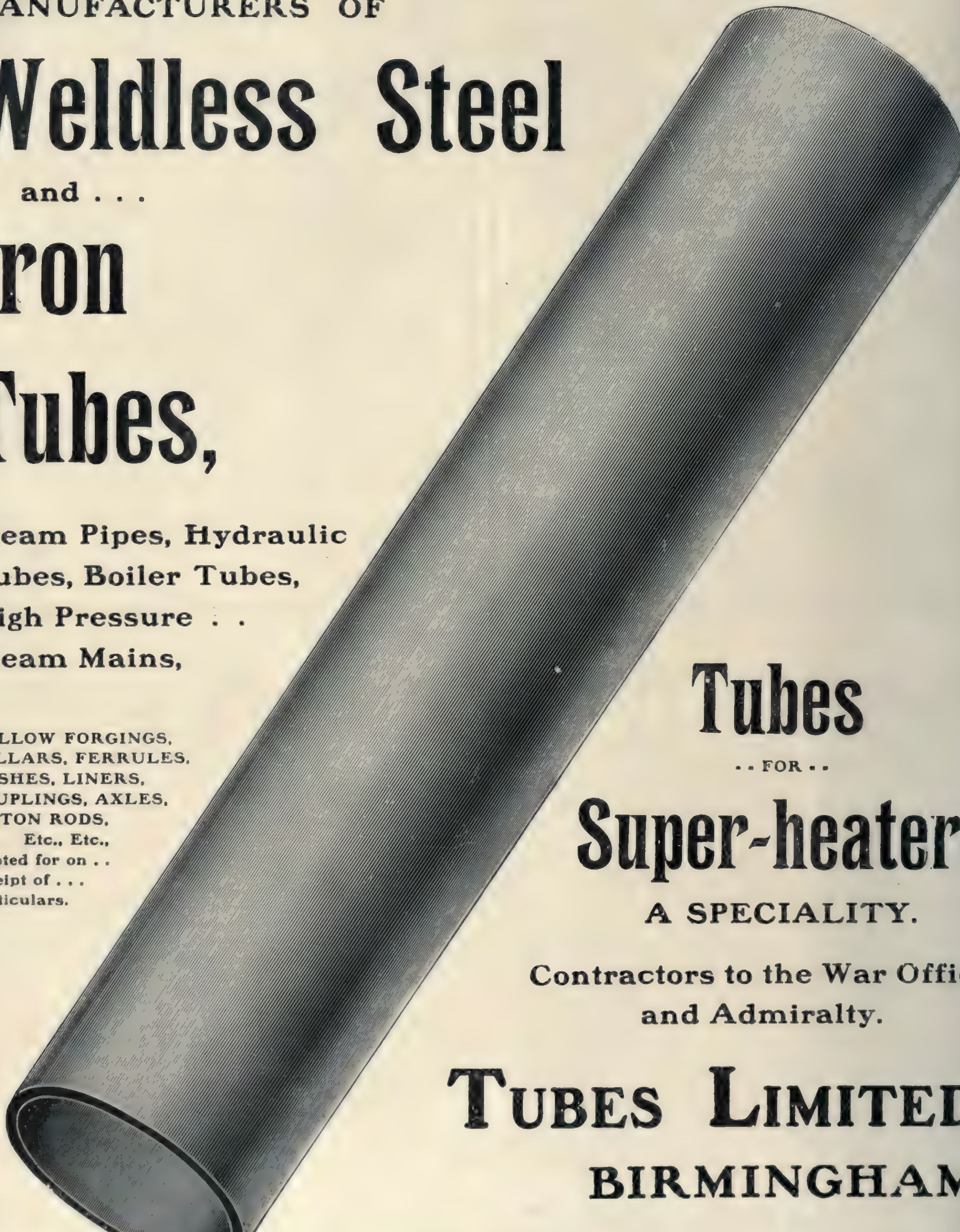

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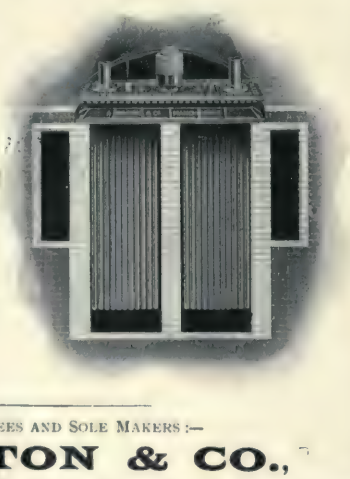

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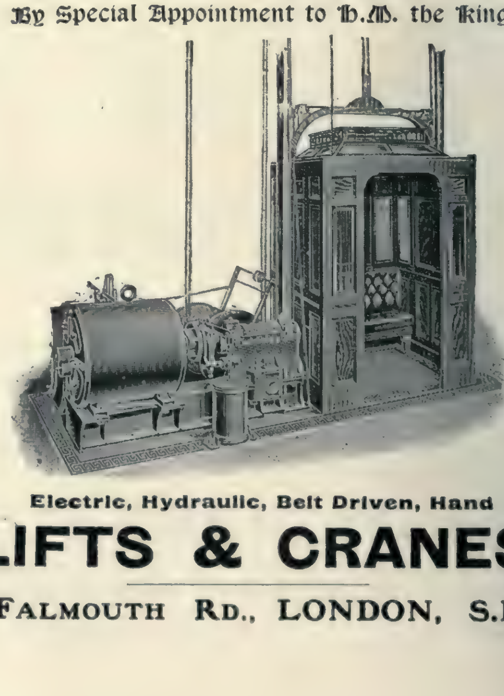

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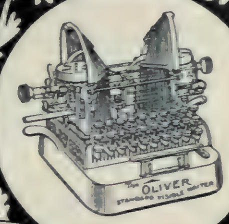

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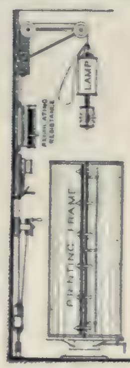

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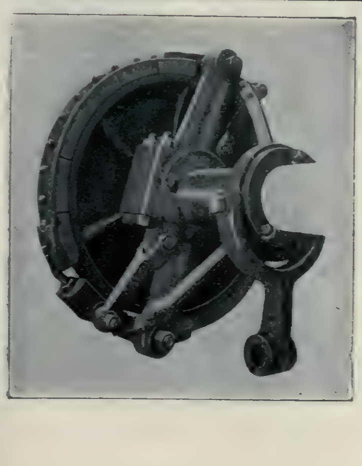

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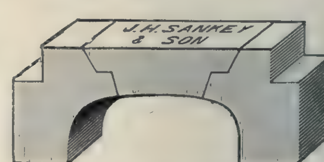

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